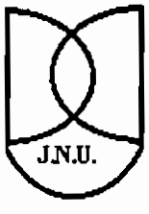
AN ECONOMIC ANALYSIS OF COSTS IN A DIGITAL LIBRARY: A CASE STUDY OF CENTRAL LIBRARY IIT, DELHI

Dissertation Submitted to Jawaharlal Nehru University
In Partial fulfillment of the requirements for
the Award of the Degree of

Master of Philosophy

By
Geeta Verma



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CERTIFICATE

Certified that the dissertation entitled **An Economic Analysis of Costs in a Digital Library – A Case Study of Central Library IIT, Delhi** submitted by **Geeta Verma** is in partial fulfillment of eight credits out of a total requirement of twenty-four credits for the degree of **Master of Philosophy** of this University. This dissertation has not been submitted for any other degree of this University and is her own work.

We recommend that this dissertation be placed before the examiner for evaluation.

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Chapter 1

Introduction

Education is considered a long-term investment in human capital formation. However, it is quality education which improves the productivity, knowledge, as well as the capacity to understand and other such aspects of human capital formation. And it is technology which has always had profound impact on quality of education imparted in general and higher education in particular. In this millennium, particularly at the onset of the twenty-first century, higher education is particularly affected by the impact of Information and Communication Technology (ICT) revolution that has shown its effectiveness and importance in every other sector of the economy.

1.1 INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT)

Information and communication technology (ICT) is an integrated technology, which includes computer, telecommunication and magnetic storage media. The Computer is a core instrument of information technology that has gained much popularity in almost every sphere of education, a supremely efficient vector of communication, place where freedom of thought may be exercised. ICT welcomes all who use it, but it is only accessible to those who have the requisite electricity, computer, telephone hook ups and know how to use it (Mayor, 1998).

The ICT has changed the way to capture, store, process, transport and disseminate of information and also have profound impact on the way societies are organized. These capabilities are reliable, inexpensive and present vast potential for networking and sharing of information in the digital format across national and international boundaries. These features combined with advanced telecommunications have created unprecedented kind of infrastructure often called cyberspace and information superhighways. Established networks like Internet attract a broadening base of participants, which have been interconnected nationally and globally through information highways (Hamelink, 1997)

From ICT revolution emerge a new kind of economy-the information economy in which information is a critical resource and which is basis for technological advancement, competition and governance. Old ways of governance are being challenged and sometimes reformulated by new technologies. Electronic Commerce (E-com) is emerging as a new form of economic activity, even though some countries are not fully prepared for it. ICT in developing countries are transforming old challenges and creating unprecedented possibilities for sustainable economie development just as it did for business and the industrial world during the industrial revolution. But unlike the industrial revolution, not only the developed the developing countries are also presenting potential for leapfrogging in the applications of ICTs in various areas, specially edueation.

Even the World Development Report (1998) has most appropriately focused on "Knowledge for Development". The report highlights various attributes of knowledge that differentiate the developing countries from the developed one.

Table-1

Availability of ICTs in Selected Countries (Per Thousand Person)

Country/Region	Radio	TV	Telephone	Mobile	Personal computer	Internet use
India	105	64	15	0	1.5	.05
Pakistan	-	24	18	0	1.2	.07
Nepal	57	4	5	-	-	.07
Bangladesh	48	7	3	0	-	0
Sri Lanka	195	82	14	4	3.3	0.33
China	161	252	45	6	3.0	0.21
High Income Countries	-	-	546	-	199.0	111.0
World	**-**	**-**	**133**	**28**	**50.0**	**34.75**

Source: World Development Report, 1998/99

Estimates have shown that in 1993 there were approximately 173 million computers in the world and nearly 43percent were in USA alone. Another 40 percent of computers were used in the other 17 large industrialized

and developed countries, such as Japan, Germany, UK and France. This leaves nearly one-sixth of the computers for remaining 200 countries of the world (Williams, 1998). Therefore, it poses an arduous task for country like India. However, developing countries are developing and deploying the large scale IT applications in education, research and administration.

Education, as a producer of knowledge, is frontrunner and spearheading ICT related developments. The curriculum in developed countries, at all levels of education, has been redesigned and greater emphasis has been put on the use of ICTs. The educational system of developing countries are still recovering from the shock waves of the ICT revolution that has already taken place in the developed world during the last two decades. In this scenario, it become necessary to know what tools the ICT is offering. The following are the major tools:

Electronic Mail (E-mail): E-mail is the process of sending message to other people or program on other computers. It is the most extensively used service because it is extremely fast and very inexpensive. It saves time, effort, money and resources. E-mail has several advantages when compared to postal delivery and the telephone. E-mail is particularly effective for 'one to many' correspondences.

Telnet: Telnet is an application tool for connecting a remote machine and working on it. It is used to access a lot of public service points including library catalogues and other kinds of databases. Telnet is the most frequently used facility for remote login within the Internet and runs over transfer communication protocol/Internet protocol (TCP/IP).

File Transfer Protocol (FTP): FTP requires full access to the Internet. It makes possible to transfer files between two Internet connected computers easily and quickly. Depending on network traffic, it may take a few second to transfer large amount of information from public archives. An anonymous FTP server allows any user to download files or programmes.

Bulletin Board Systems: Bulletin Board system creates the possibility to engage in group-discussion and create an interactive community. BBS makes many-to-many communication possible. It is an ideal medium for asking and giving help, as this system is mostly local and not very expensive, sometimes free to callers.

World Wide Web (WWW): WWW is one of the newest of the Internet front-end. It is an innovative attempt to allow users to access Internet information and services. This allows the user to click on words or other data contained in files perused on-line, and the program will connect the reader with additional files or other documents related to the highlighted keyword. Using web, hundreds of sites can be accessed without actually knowing the address of other sites or location. Web resources are identified with a special name called URL (Uniform Resource Locators). URL identify subjects that may be accessed on the web.

1.2 HIGHER EDUCATION IN TRANSITION

The history of higher education in almost all the Third World countries is comparatively short, extending back to the last 200 years, at the most, which is in sharp contrast to the long centuries of its history in developed countries. National development goals of the higher education institutions appear to be relevant for the immediate future of the next two or three decades. However, within global perspectives, a system of higher education by its very nature cannot sustain itself in the long run if it loses sight of some of its basic aims. These important, basic, on-going aims of the higher educational institutions are known to be acquisition, transmission and extension of knowledge of the highest kind.

Even, Indian higher education had a glorious past as reflected by its universities like Nalanda, Takshashila and the Gurukul system, which was appropriate for the agrarian society. This system was providing the knowledge of its kind, as keeping in mind the development of country and need of its

citizen. During the 50 years of independence, India has widened access to higher education quite extensively. The form of education during this period was the typical institutionalised teacher-centric system, considered relevant to industrial society. But, in the present millennium, information communication revolution is sweeping the world. India with the rest of world is now at the stage of changing over to an information focused society. As many institutions, organizations and agencies in the country are employing communication technologies in a big way in all sphere of life. Computer literacy and applications are spreading very fast; email, Internet and other network access is becoming widespread. The Indian higher education is also changing under the impact of these processes of technological invasion.

In Indian scenario, Higher education is adopting ICTs slowly and steadily. However, face to face instruction and print material are still being used within our conventional university system. This kind of lecture system is very effective when delivered by a good teacher, but it loses it effectiveness if the teaching is of poor quality. In other words, learning is dependent to a very great extent on an individual. Therefore, the use of new technology in higher education can offer the new alternatives to classroom teaching and learning as well. The modes of new technologies provide different media to connect each other over distances. The assumptions behind the ICTs are that (I) the technology with its phenomenal reach can achieve **equality** in the provision of education, particularly across geographical barriers (ii) it can lead to **economies of scale** in the provision of educational facilities. (The other problems faced in Indian education system are mainly-equality, quality and resources).

Therefore, new technology would be likely to change some of the problems of higher education system. Besides, information and communication technologies have shown their effectiveness in developed countries with regard to imparting education. Universities in other part of the world are grappling with how to transform themselves to cope with challenges and opportunities

posed by information and communication technologies (ICTs). An Australian study reveals that academic work in the twenty-first century is changing its ways, as many universities are looking at the ways in which the use of information tcchnology can bc "main streamed" across thc univcrsity. These changes requirc coordination, planning and resourcing at an institutional lcvcl (Coldnake & Stersman, 1999, p.7). In United Kingdom, a report for the committee of Vice-chancellors and Principals on "Borderless Education" argued that universities would have to have customer-focused approach" to education and training, with more virtual learning (Green and Gilbert, 1995).

Therefore, all over the world, higher education system is transforming itself to adopt the challenges in the system. Some of the tools of new technologies are gaining popularity in general and academics in particular. Furthermore, half of the world's population would likely to be linked by Internet by the year 2020. Even in India, total number of Internet users are around 700,000 so far and it is assumed that this figure would increase drastically very soon.

The new technologies have proved to be a boon to the individual teacher and have greatly increased her/his productivity compared to the old pattern. The teachers using ICT require little secretarial assistance, and are yet able to prepare their own teaching materials, research proposals and other documents, all this being achieved at lesser operational costs. The new technologies have increased academic productivity, enhanced traditional teaching and have brought changes in pedagogy and curriculum content. One can say that technology, in general and information technology in particular has radically altered the possibilities in educational procedures.

1.2.1 INFORMATION AND COMMUNICATION TECHNOLOGY INFUSION IN HIGHER EDUCATION

New information and communication technologies, especially the Internet is offering opportunities to researchers, educators and administrators

all over the world. Now, they all can interact with one another. In other words, scholarly community may exchange ideas and form a kind of global university. One example is the University of Phoenix, the largest private university in the USA, which is enrolling 65,000 students out of which 10,000 students will be learning exclusively online (Marcus, 1999, p.11). The emergence of these technologies has revolutionized our ways of thinking. Moreover, it has opened up heady prospects for creating worldwide links among universities, institutions of higher learning and libraries. It is promoting personalized teaching and disseminating knowledge that is tailored to the needs of individuals and groups.

Technology infusion in higher education institution, from admissions to housing, from extra-curricular activities to teaching-learning process has shown its future prospects. The computer communication convergence has made knowledge accessible, quickly, effectively and practically all over the world. Mashelkar (2000) explains that the march of new technology will change the way we teach and learn, both in space and time. Indian Prime Minster has referred to information and communication technology as "India's tomorrow" and it must be used for our development in all the possible ways.

A study conducted by Lord Dearing's National Committee of Inquiry into Higher Education (NCIHE, 1997) revisited the purposes of higher education in the United Kingdom. This report discloses the objectives of higher education in new culture. The objectives are:

- Inspiring and enabling individuals to develop their capabilities to the highest levels;
- Serving the needs of the economy;
- Shaping a democratic and civilized society.

Higher education in the United Kingdom has undergone massive expansion over the past twenty years (Boucher, 1998, p.87). Over this twenty year period total funding for higher education has increased in real terms by 45

percent, although the unit of funding per student has declined by 40 percent in real terms. Dearing report mentioned that many universities have revamped the whole teaching-learning process due to increased pressure by financial constraints. These universities have responded to challenges by adopting alternative ways (new technologies) of teaching-learning. Consequently, international colleagues would see each other at the occasional conferences, write letters, or rack up sizable long-distance phone bills. Today, Internet allows inexpensive daily interaction between colleagues around the world. It is useful to take an occasional snapshot of the opportunities and their impact on the academic life and work. Some of the opportunities are discussed below:

International Collaboration

Putting together an international collection of essays has never been easier. However, in present scenario, these things have become very simpler as books chapters can be solicited, reviewed, edited, designed and printed using a standard desktop computer with an Internet connection and a laser printer. Traditional forms of research collaboration printing, mailing and waiting for a response, are being replaced by faster scale. For example, **Listserv** email discussion groups make possible the international sharing of research questions and findings, which sometimes, leads to research partnership between academics and business community that discover their shared interests on-line.

Publishing Impact

With a desktop PC, an Internet connection and a web hosting service anyone can be a provider of information to the masses at amazingly low cost. By developing and maintaining websites, research essays and agenda can be published on the web. New web- based newsletters and journals are cropping up every month, as faculties have learned to make use of this mode of publishing in their work throughout the world. The impact of the Internet on information distribution is enormous, much like the introduction of the printing press years ago (Forest, 2000).

Access to Information

More websites means more information at our fingertips, for example in United States, students are turning increasingly to the web as a primary source of information what previously obtainable only at their school library. The same information is also available to Internet connected students and scholars in other countries, it may be the technology drivers that attract community. The meaning of driver is that, university teaching is essentially the transmission of information from teachers to students. Now that lecture notes can be available on the web so there is no reason for student to go to the lectures. In other words, every student can have access to the best lecture in the field.

Easy access to information has made international education an industry. It is estimated that there are more than 1.3 million international students studying outside their country of origin (UNESCO, 1996) where Almost half students (47percent) come from Asia .The United States which is host to the majority of the world's international students, has discovered that its universities and colleges are receiving less students because of off-shoring and distance learning through information and communication technologies. Portar&Millar (1985) postulated that ICT has the ability to positively enhance the "value chain" within many enterprises. Applications of ICT can provide competitive advantage by lowering costs, enhancing differentiation and creating new opportunities to broaden economics of scale. Economic Growth in the Asia-Pacific rim particularly in China, India and Pakistan represents enormous opportunities for delivering education. A study of the international marketing strategies of education institution has highlighted the importance of information technology as a potential source of competitive advantage (Mazzarol, 1998).

As the workplace and homes throughout the world are linked by communication and information technology networks, greater use of this will rapidly translate into a viable international distance education sector.

Teaching and Learning Tools

Desktop PC, video conferencing, Internet have shown their importance in academic world. It allows digitized images, graphics as well as statistics to be transmitted simultaneously to several students via ISDN. Desktop conferencing is easy to use in conjunction with a PC and more intermediate form of interaction with students across the world.

In the United Kingdom, changing nature of delivery system has given momentum to development of ICT. Some of the major projects are the teaching and learning technology program (TLTP), the computers in teaching initiative(CTI) and the Joint Information System Committee(JISC). A report reveals that "these initiatives, along with complementary activity throughout the sector, are leading to the development of a different types of higher education in terms of the process of teaching and learning and what is delivered within this process"(Mazzarol, 1996). Again, the future of new technologies, mix with other technologies is likely to prevail in the higher education system. Internet, CD-ROM and the emerging Digital Video Disc (DVD) formats are likely to predominate for the immediate future for course delivery. Advances in graphics file compression technologies have already overcome obstacles to using dense graphical information on the Internet.

Higher education is bound to go for the unavoidable shift from the culture of print to a culture of digital conferencing. It affects not only teaching, learning and research, but the whole of university life. Today, a faculty member and a researcher have a different '*modus operandi*' for learning and research in their areas. In addition to the print material they generally have:

- An email address of the library or the department;
- Connection with online e-print archives, dealing with ongoing research in their respective areas with access to World Wide Web and other databases on the Internet;
- Access to data transmission lines, terminal and laser printers;

- Access to desktop machine and data libraries
- Access to electronic library as gateway to global knowledge (Powar, 2000, p13).

Impact on Academic Library

In early 1970s, information systems for libraries were built in the era of mini and mainframe computers, providing remote access, online search and retrieval services to users. It was around this time when the libraries especially in the developed world started applying a growing range of information technology. Several integrated library packages were also launched to automate in-house operation of the library including circulation of books, ordering of books and online public access catalogue (OPAC). Online Public Access came as a replacement for the traditional card catalogue. These IT applications not only made manual processes more efficient, they also opened up the library collections to the researchers. Through online catalogue, users could search the holdings of library from remote location without having come to library premises.

Development in ICT during 1990s, had reached a stage where computing power allow parallel processing, consultation and knowledge navigation. The user-friendly World Wide Web offered several facilities without extra effort and training. Even, technologies made it possible to use multimedia objects such as text, image, audio, and video. Afterward, technological evolution has led to a platform where all computer based information product are built around the Internet and evolving web technologies with full text components incorporated in it. Now, libraries have become "access points" to global resources, in addition to being physical depositories of learning material.

1.2.2 IMPACT OF TECHNOLOGIES IN HIGHER EDUCATION: THE INDIAN SCENARIO

Indian higher education system has three-tier system (I) Primary education (II) Secondary Education (III) Higher education, which is also known as university education. Indian higher education plays a vital role in national development. As higher education is considered to be the " tool of production" in any kind of development, now information and communication technologies are changing the ways information is gathered and retrieved all over the world. Indian higher education system is responding very positively to these new changes and incorporating these technologies in every sphere of the system. Within the domain of higher education system the following processes employ information and communication technology extensively:

Teaching-Learning Process

Onc of the most important ICT development took place in teaching learning system, where audio and video were added to make it more efficient. Becausc, higher education was facing the challenges of widening the access to larger number particularly the disadvantaged groups. At the same time they had to ensure relevancc to its program to the needs and requirements of fast changing society. The new technologies provided excellent opportunities to ensure quality education. For example, Indira Gandhi National Open University (IGNOU) which is a prestigious university of India, engaged in distance education that is catering to the needs of large number of students with the help of ICTs. Teaching-learning process becomes quite easy since tele-counselling and online courseware help in the process. In the changing scenario, students can contact their teachers any time anywhere with the help of email facility. Besides, IGNOU, other open universities are also following these patterns. Even, Institutes of national importance e.g., IITs are also providing counselling, online courseware etc through the Net. IGNOU is

establishing the network of open universities in India which is known as "OPENNET".

Research

World Wide Web related resources have become increasingly viable components in research because Internet provides the plenty of information scattered on the web within few seconds. These days, researchers are using the literature available through the web, as it is easy to gather. These informations can be retrieved from anywhere, anytime at low operational cost. The advent of computer and development of certain software packages has made complex analysis much easier than before. The quantitative analysis through SPSS packages, Fox Pro, Lotus, SQL, E-View and other related software have made multivariante analysis easier and faster. These facilities are now widely available in most of the Indian universities.

Management

Management of any kind of information can be a tiresome job if not organized properly. However, it has become easy to handle information with the help of computers in any university. Now universities store any kind of records pertaining to students on the computer because information can be retrieved in a flick of moment if stored in computer. The introduction of e-commerce has further facilitated the universities banking operations. Financial management and accounts operation is possible through software that is freely available in the market. With the use of multimedia, computerized identity cards have been issued to staff and students in some institutions. The central university Delhi is providing online information related to new registration on the web and application form can be filled up on the net. This service has decreased the problems of students.

The Store House of Information –Library

The library is considered as storehouse of information and core of information for any university. However, the nature of access to information is changing rapidly and radically. The source of change is the Internet and the web technology. It has changed the way of production and access of information compared to conventional library system. High cost of journals and technological changes have forced libraries to adopt new changes. Other rationales are:

- Growing number of scholars and institutions access the World Wide Web
- Electronic format allows to change the pattern. The journals are freely available at low price and are easy to access.

Today, access to electronic journals and online information service has become integral part of library system. Libraries are also acquiring the other sources of information like CD-ROMs and mounting them on the web for wider access.

The Indian libraries are not aloof from the developments taking place around the world, as most of the libraries have started automation. Library networks, online services and email facility have already become operational or are in the process of becoming operational in all universities/colleges. Resources sharing has become need of the hour in India due to financial constraints and high conversation rates. In this regard, it is worthwhile to mention that IITs have signed a memorandum of understanding among themselves to form a consortium to achieve the goal. Furthermore, library networks have been formed, like DELNET, INFLIBNET, and CALIBNET. Other library networks were started long ago in one form or the other in Mumbai, Chennai, Banglore, Mysore, Pune and Ahmedabad.

Government's Initiatives

A "Task Force on Human Resource Development (HRD) in information technology" was established by the Government of India in 2000. Taskforce made to chart the plan of action to cope with challenges of IT and how institution of higher education should respond to these challenges. The main objectives of taskforce are:

- Leveraging IT for modernization of library support services.
- Curriculum and Courseware Initiative
- Computing Facilities and Connectivity
- Promoting interface with industry

This taskforce has given many recommendations. One of the recommendation is that institutions should be provided financial assistance for strengthening computing and networking facilities.

In July 1984, the Working Group of the Planning Commission on Libraries and Informatics recommended the need for modernization of library services. Therefore, a Calcutta Library Network (CALIBNET) was established. In 1988, New Delhi with the help of NISSAT began Delhi Library Network (DELNET) to cope with technology invasion, which later on called as Information and Library Network (INFLIBNET). This was University Grant Commission (UGC) project INFLIBNET would be likely to link 200 R&D institutions. Apart from that, it would provide financial support to 54 universities and help to 170 universities and 500 college libraries for library automation.

1.3 THE NEED OF THE STUDY

Poon (1999) says that "information is power" as it is not only the base of any planning, rather, has become necessity for a system. Information handling has become important task for each institution, universities and organization. These ICT facilities have proved their potential. The inability to collect and

disseminate information properly would prove costly for the society in the long run.

ICT in developed countries have shown their impact on higher education system and their counterpart in developing countries are striving to follow them at affordable costs. Institutions of higher learning have wide scope to incorporate it and library being the storehouse of information have become the focal point, therefore, they can not be silent spectators to these new technologieal changes. Though they are welcoming new technologies and are in the process of it, main hurdle is the cost of these changes because slow down in economy have forced universities to cut down their expenditure, but it is high time to respond to the changes. Therefore, it is essential to know that on what cost we are adopting to these technologies. To understand the problem, it is neccssary to conduct a study which could analyse the cost components in the digital library since literature does not provide substantial information on the topic.

The present study would try to analyse the cost components in a digital library. We would look into the functioning of digital library and also try to explain the place of ICT in the higher education system.

1.4 OBJECTIVES:

The objectives of proposed study are as following:

To find out the

- Role of Information and Communication Technology in improving the quality of academic sector.
- Functions of a digital library in the institution of higher education, particularly technical education.
- Fixed and Variable costs involved in digitisation of IIT Central Library, Delhi.
- Development cost of various forms of Information Technology in the digital Library and also find out the unit cost of each form.

SCHEME OF THE STUDY

Chapter 1 highlights the importance of information and communication technology in higher education system with special reference to India. Further, need of the present study and objectives have been discussed.

Chapter 2 presents an overview of digital library and also highlights the initiatives taken in the process of digitization of library across the world.

Chapter 3 presents review of literature and also discusses the methodology of present study.

Chapter 4 provides the economic analysis of costs in central library, IITD.

Chapter 5 accounts the summary and conclusions.

Chapter 2

Digital Library: An overview

History has repeatedly shown that a new technology completely displaces an older one over time. The same is happening with print and electronic resources. Since the information technology and especially networking systems have had an impact on every aspect of the traditional organizations, library is also not exception to it. The evolution of digital libraries can, to some extent, suppress the challenges facing the higher education system (Smith, 1997). Because information is expanding at very fast track, making the right information available to the right person at the right time is the aim of any modern library today. The high rate of growth of information has made it impossible for any library professional to rely solely on manual or semi-manual methods of information handling in order to achieve this goal. Hence, the modern library no longer consists only of books and serials but also contains information in various machine- readable forms, such as floppy diskettes, CD-ROMS and DVD etc. Therefore, application of information technology to library and its activities has revolutionized the library services. Though the librarian witnessed the application of computer in 1960s, yet the concept of 'virtual library' is still in its infancy. Different phrases such as "digital library", "virtual library" and "library without walls" have been used interchangeably to describe this broad concept, where Digital library is the most current and widely acceptable term.

2.1 A HISTORICAL PERSPECTIVE

Brand (1999) illustrates that the convergence of telecommunication and computer technologies in the context of libraries has been the product of continual development rather than a sudden movement. Computer application in library first appeared in the U.S. The system was created at the Wealth Law Center at the University of Pittsburgh to assist in the drafting of Law text and later on used by Department of Defence in project - the Legal Information Through Electronic System (LITE).

1970 witnessed the new storage device called "*videotape*" which was introduced by Ampex and in 1971, Philips demonstrated the first home video colour tape recorder and play back machine .The Ohio state universities libraries introduced an online remote access catalogue and circulation system. During 1971 IBM developed its Storage and Information Retrieval System (STAIRS) which was available commercially, too. The online system allowed *boolean* searching on the full text of citations and abstracts and is still widely used (IBM, 1971). By 1977 the microcomputer was beginning to show signs of the future impact. Between July 1981 and July 1982, the National Library of Canada produced a number of videodisc programmes linked to the minicomputer. The microcomputer operations in libraries spread rapidly in 1980 and the early 1980's saw a renewed interest in information provision linked to the "new" technology and a desire on the part of Governments to explore the relationship between creator, publishers, exploiter and end users. In early 1990s, the World Wide Web was perhaps the most notable example of a striking element that library neither predicted nor planned for (Miller, 2000). From 1989, when Tim Bernerslee and others at CERN (European High Energy Physics Laboratory in Geneva) developed a hypertext system, we grew from about one percent of backbone traffic in September 1993 to about 20 percent by 1995 and had continued to expand dramatically (Waters, 1992). Finally, the web became the focus in 1993 when the graphical browser Mosaic was introduced and followed by Netscape Navigator and Microsoft's Internet Explorer (Cox, 1997).

2.2 DEFINITIONS

Terence R. Smith (1997) described digital libraries as "*controlled collections of Information Bearing Objects (IBOs) that are in digital form and that may be organized, accessed, evaluated and used by means of heterogeneous and extensible set of distributed services that are supported by digital technology*"(as cited in Arora, J., 2000).

Clifford Lynch (1995), a well known expert on Internet and web technologies, defined digital library as a *"system providing a community of users with coherent access to a large organized repository of information and knowledge. The digital library is not just one entity, but multiple sources are seamlessly integrated"*(p.25).

Association of Research Libraries (ARL) has defined a digital library as having these qualities:

- The digital library is not a single entity.
- The Digital Library requires technology to link the resources of many.
- The linkages between many libraries and info-services are transparent to the end users.
- Universal access to digital libraries and information services is a goal.

Cleveland (1999) elaborated the concept of digital library. He said that a digital library would have these characteristics:

- digital libraries are the digital face of traditional libraries and include both electronic as well as print and other (e.g. film, sound) material,
- digital libraries can also include digital material and outside the actual boundaries of anyone digital library, and
- digital libraries include all the processes and services offered by traditional libraries.

2.3 FUNCTIONING OF DIGITAL LIBRARY

2.3.1 COLLECTIONS AVAILABLE IN DIGITAL FORMAT

The CD-ROM is one of the growing storage devices, which uses the laser power and optical techniques. This new device is called CD-ROM and can store more information than any other external storage device. CD-ROM is made up polycarbonate having 12 cm of diameter with only 1.2 mm thickness. It can accommodate enormous information (550 MB) which is equivalent to 2,75,000 to 3,00,000 A4 size written pages of text or 450 MB high-density

floppies (Kapila, 1999). Even a single disc can store the entire Encyclopedia Britannica. The usage of CD has gained popularity due to easy availability of CD-ROM and low cost. The convenience and mobility factor of any CD-ROM product make it more unique, as CD-ROM can be used on any PC with fitted CD-ROM drive. CD-ROM networking technology is now providing web-based access to CD-ROM on the Local Area Network (LAN) as well as on Wide Area Network (WAN). Libraries have an option to subscribe to three full-text databases as a part of their digital library. Silver Platter's Electronic Reference Library (ERL) technology facilitates integrated access and search of ERL-complaint databases through an Intranet server. Advancement in technology has brought new devices e.g. DVD, as a media with high storage capacity and longtivity. A detailed share break-up of the database in CD-ROM published by different countries have been enumerated below:

Table 2.1

CD-ROM Databases by Different Countries

S. N.	Country	Database number	Share %
1.	USA	4766	49.103
2.	UK	1534	15.084
3.	Germany	1170	12.054
4.	Canada	649	6.686
5.	France	333	3.430
6.	Italy	2993	3.018
7.	Japan	224	2.307
8.	The Netherlands	142	1.772
9.	Spain	113	1.164
10.	Australia	95	0.978
11.	Belgium	87	0.896
12.	Mexico	82	0.844
13.	Austria	47	0.484
14.	Switzerland	47	0.484
15.	Israel	30	0.309
16.	Sweden	27	0.278
17.	Russia	37	0.381
	Total	**9706**	**99.992 or 100**

Source: www.ARL.org

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Jawaharlal Nehru University Library

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2.3.2 ACCESS TO EXTERNAL COLLECTIONS

Recent developments in computer technology and use of the World Wide Web (www) have brought major changes in access, collection and use of scholarly journals in the libraries (Cronch & Overfell, 1995). The growth of electronic journals has been exponential. A recent analysis reported that the availability of scholarly e-journals have also grown despite the uncertainty of e-journals pricing (Oesdel and Born, 1998).

Table-2.2

Growth of E-Journals and E-Conferences

	Growth of E-Journals and E-Conferences						
	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
E-journals	27	36	45	181	306	1093	2459
E-newsletter	83	97	175	262	369	596	955
E-conferences	517	769	1152	1785	2480	3118	3807
Total	627	902	1372	2228	3155	4807	7221

Subject Wise

Subject Break down	**Journal**	**News letter**
Art & Humanities	13%	6%
Life Science	35%	16%
Physical Science	13%	6%
Social Science	24%	41%
Technology	10%	21%

Source: ARL, 1997

Poon (1999) argues that traditionally acquiring and providing access to journal collections have been well structured and standardized. But one of the major problems with journal collections has been the issue of how we balance the ownership and access as journal cost is increasing continuously by annual average of 9.4% (ARL Statistics, 1997).

Types of Electronic-Journals

On the basis of distribution methods, the following types of the e-journals can be identified:

Classic Journals: Some of the electronic journals are available through Internet applications, which are called classic journals. Originally, they were distributed via e-mail but now, are available on the web and only announcements of new issues are distributed by e-mail to this category of e-journals, free of cost.

Parallel Electronic Journals: These types of journals are published simultaneously in both forms-print as well as electronic. The online version may include the full text of journals or selected articles and excerpts from the print version. The electronic version is always available much more before its print counterpart.

CD-ROM Journals: Commercial publishers have also made journal titles available on CD-ROM. The full text of journals and newspaper have been made available on CD-ROM. Libraries have often subscribed to journals both in print and microform.

Publishers are very much concerned about providing access to their printed material in electronic form, at the same time, economics of e-publishing become major issues for them. The pricing of e-journal vary significantly in digital era. The publishers make a significant investment in the process of production of a journal which involve many activities like peer-review, administration, editing, layout design, production management and distribution. Some of the activities are permuted for publishing a journal is common to both electronic and paper media, except for production and distribution. However, a study concluded that the cost of electronic journals could not be substantially lower than their printed versions. Journals are available through the web at varying price models. In a survey conducted by EBSCO, it was found that 50

percent of journals are free with print journals, 34 percent require print subscription and 16 percent are available online only without their counter-part. Overall 84 percent of journals require a print subscription as a prerequisite for online access to their electronic version.

2.3.3 DIGITAL DATASETS

The libraries or the institutions have always some datasets that are originally created in digital format. In this electronic age, doctoral dissertations submitted to universities and research institutions are generally created in digital format, which are invaluable for any institution or library. Therefore, these "born digital" resources can also be transformed or converted into digital collections which are available on web. Besides, technical reports, annual reports, university newsletter or any other important data may also be included in this section.

The documents composed on word processing package or desktop publishing package can be converted into HTML, PostScript and PDF using different tools. Online converters are also available through Adobe's site. HTML, as a "de facto" language of the web and PDF as a "de facto" standard for online distribution of electronic information, can be used to facilitate transition from computer accessible files to web accessible (Waters, 1992).

2.3.4 DIGITIZATION OF PRINT MEDIA

Several digital library projects are connected with digital access to information that existed with traditional libraries in printed media. Scanned page images are practically the only reasonable solutions for this purpose. Where Printed text, pictures and figures are transformed into computer-processible forms using a digital scanner or a digital camera in a process called "document imaging" or *scanning* (William, 1986). There are several large projects using page images on their primary storage format, including project *JSTDR* (www.jstor.org) at *Princeton University* funded by the Melon

Foundation. The project JSTDR has a complete set of more than 120 journals hosted on the web server. This project used technology which had been developed at the University of Michigan using high resolution (600 dpi) bit-mapped images of each page with optical character recognition (OCR) software (Guthrie, 1997).

Capturing page image format is comparatively easy and inexpensive, it is a faithful reproduction of its original work while maintaining page integrity and originality. The scanned textual images however are not searchable unless it is OCR, which, in itself, is highly error prone process especially when it involves scientific texts.

Tools of Digitization

A typical scanning workstation for a small production level project, could consist of the following components: Microcomputer – Pentium II to Pentium IV, Scanner and Scanning Software, Storage System, Network, Display System, Printer.

2.3.5 LINK TO THE ELECTRONIC COLLECTIONS AVAILABLE ON THE WEB:

With the development of the World Wide Web in mid 1990s, the trend toward electronic publishing has accelerated tremendously and the pace of change has quickened. Varian (1997) pointed out in a paper delivered at Emory University *"It is widely expected that a great deal of scholarly communication will move to an electronic format. The Internet offers much lower cost of reproduction and distribution than print, the scholarly community has excellent connectivity, and the current system of journal pricing seems to be too expensive. Each of these factors is helping push journals from paper to media"*(p.35).

Besides e-journals the web allows rapid access to a wide variety of networked information resources. The web, being a hypermedia-based system,

allows linking amongst electronic resources stored on servers dispersed geographically on distant locations. The portal sites provide link to the main creator of the original digital material. The portal sites restrict their operation to providing linkages to independent third party sources. Home page of all the major education and research institutions, specially in developed world, provide an organized and structured guide to electronic resources available on the Internet.

2.4 IMPORTANCE OF DIGITAL LIBRARY:

Since Digital libraries can manage large amounts of content such as thousand of images or hundreds of audio clips and also to perform searches that are manually impossible/impractical (Arora & Lekhi, 1999). The growing use of multimedia data has introduced new challenges in storage and communication of diverse multimedia objects like video, audio and images .The World Wide Web (www) makes it easier to transfer such information over national and international networks. The following point will help us to understand the objectives of modern libraries and why we need libraries those are equipped with new technologies (digital libraries).

Information Explosion: An exponential growth of information has been noticed during the last three decades. This growth has its greatest impact in the areas of science, technology and medicine. A study carried out by Chemical Abstracts Service and Organization of Economic Cooperation and Development (OECD) in recent years revealed that the volume of information is increasing at the rate of 13 percent per year which means that the total amount of information doubles every 7-8 years. This phenomenon is popularly termed as "*information explosion*" (Arms, 2000 & Lesk, 1997).

Therefore, emergence of Internet and web technologies as a medium of information delivery and access is providing support to libraries. As, in the present scenario, information handling is becoming very costlier and unmanageable job. The Internet, particularly World Wide Web (www), allows

rapid access to a wide variety of networked information resources and extending a uniform interface to a vast number of multimedia resources.

Time Saving: The term "digital library" refers to a system which carrying out the functions of a library encompassing new electronic resources. These electronic resources are easily accessible through the Internet and mostly from outside the library premises. Technology (Internet Explorer and Netscape Navigator) makes the user interface simple and friendly. Therefore, availability of extraordinary simple and intuitive user interface force user to take help of digital library and receive the material segmented and arranged, instead of spending hours in scanning of the material in the library. The data (information) stored in digitized form can be retrieved almost instantaneously.

Space Conservation: There is an acute shortage of space in almost all the libraries in the world. The storage of information in compact disk (CD-ROM) would definitely reduce the pressure on space. For instance, the printed version of the "Encyclopedia Britannica", which is in 30 volumes, occupies about two shelves of library space. A 650 MB CD-ROM disk can store more than 2,50,000 pages of information or the entire Encyclopedia Britannica (Park, 1999, Cronin B. (1995). The CD-ROM copy of this encyclopedia, with 145 mm X 130 mm X 10 mm dimensions of the plastic enclosure occupies only a fraction of digital library. This provides a help/relief to library and information manager.

Access To Nascent Information: Information is available in a variety of form like printed form, microform and digital form. The scientists need nascent as well as retrospective information, but nascent information is more important to them for survival in the competitive world. The scientists who have faster access to nascent information would always be better placed. Printing of information followed by its transportation across the world is a complex and time-consuming mechanism. If the same information is put on the host

computer and many computers connect it across the world, in that case, information can be accessed by anyone.

Cost-Effectiveness: Cost effectiveness is a measure of the cost of information technology and the value of results obtained. A library or organization is cost-effective if the system become efficient with decreased cost. Ekman (2000) argued that costs of creating, storing and transmitting digital information have decreased, and the technology to support distribution and access is widespread. Rising acquisition and subscription fees (not to mention shelving and processing costs) have forced libraries to seek other ways to make information available. Therefore, content aggregators and e-book publishers are providing the same.

Improved Management Information: The management of information by manual system is a time-consuming, costly and complex job. Gladieux (2000) mentions that perhaps, more importantly digital libraries support search and navigation facility. In a conventional library, manual catalogue is cumbersome, may lead to nowhere if the cards are misfiled. But searching of digital catalogues (OPAC) is faster and easier. Similarly, cutting out the required information manually from abstracting journals (Biological Abstracts, Chemical Abstracts etc) is tedious job. If at all the user succeeds in making an exhaustive search it would be time consuming (Arms, 2000). However, these problems vanish in the electronic environment

Perhaps, digital environment enables cross-community interactivity and collaboration, regardless of their physical location. Also, digitization presents opportunities for long-term preservation of knowledge. For the same purpose, several large-scale digitization projects are aimed at conserving & preserving old, fragile document of high scholarly value.

2.5 TECHNOLOGIES USED IN DIGITAL LIBRARY

Digital library requires certain technologies that could transform dreams into realities. Digital computer and digital storage are the key technologies that have made digital libraries feasible, possible and viable. The tremendous increase in the power of computers, their multimedia capabilities, the advances in software, secure languages, databases and interfaces - all have contributed to the evolution of Digital Libraries. Networking of computer and running distributed applications has helped dissolve barriers to accessing the information stored in the millions of computers around the world.

The Internet and web technologies are main tools deployed in a digital library, to navigate, and deliver electronic resources across the globe. The digital contents in a digital library can be available on a single location or distributed across the network. A typical digital library implementation follows client-server architecture. Client and server are both computer programmes. The client program typically resides on the user's personal computer, while the server program resides on a server that host information contents (Russel and Peter, 1995). The client (web browser) is responsible for making a request to the server. The most commonly used clients, called browsers, are *Microsoft's Internet Explorer* and Netscape navigator. The browsers understand different communication protocols so as to connect to different type of servers. The server is considered as the heart of a digital library infrastructure (Russel 1995). A digital library may consist of one or more servers including, an object server that stores and manages the actual digital object in a database.

2.5.1 HARDWARE COMPONENTS (SERVER-SIDE)

Servers: Servers are the heart of a digital library. Server for digital library implementation needs to be computationally powerful, have adequate memory (RAM) to handle the expected work. It should have large amount of secure disc storage for the database(s) and digital objects and have good communication capabilities. A digital library may need a number of specialized servers for

diffcrent tasks so as to distribute thc workload on to different servers. However for a smaller library, many distinct activities can be performed on a single servcr. It is vcry much important that thc scrver is scalable so that additional storagc processing powcr or nctworking capabilities can bc added whereas requircd.

Input Devices: Image based digital library implementation requires input devices likc. Scanner; digital camcras; video cameras; photo CD system.

Storage Devices: Since digital libraries require large amount of storage therefore, storage device need to be more focused. Digital library collections are too large to store on one single disk. Hierarchical Storage Mechanisms (HSM) is need of digital libraries, in a HSM the most frequently used data is kept on fast disks while less frequently used data is kept in near line such as an automated (robotic) tape library. An HSM can automatically transfer data from tape to disk and vicc-versa as required. Intelligent storage networks and snapservers are now available in which the physical storage devices are intelligently controlled and made available to a number of servers. Although hard disc (fixed and removable) solutions are increasingly available at an affordable cost, optional storage devices including WORM, CD-ROM, DVD-ROM or opto-magnetic dcvices in stand love or networked mode are other alternatives for long-term storage of digital information. Optical drives record information by writing data onto the disc with a laser beam. A number of RAID (Redundant Array of Inexpensive Disks) models are also available for greater security and pcrformance. The RAID technology distributes the data across a number of disks in a way that even if one or more disks fail, the system would still function while the failed component is replaced (Lesk, 1994).

Communication Devices: A Digital Library also requires communication equipment like communication switches, routers, hubs, repeaters, modems and othcr items requircd in a Local Area Network.

2.5.2 SOFTWARE COMPONENTS

A typical digital library requires a number of software, which may be obtained as a single integrated package from a single vendor. IBM DL and Elsevier's Science are amongst very few integrated digital library solutions that are commercially available. IBM Digital Library (Hulser, 1997) is an integrated solution for storage, management and distribution of all types of digital contents including text, images and video. It incorporates functions of creating, capturing, storage, management, distribution and right management of digital intellectual contents in an open, scalable, multi platform environment e.g. WINDOWS NT.

While Elsevier's Science Server (Science Server 1999) provides an effective and powerful information system that provides an integrated access to database(s) and digital collections hosted on local intranet servers as well as other bibliographic and full text databases that library is authorized to use. It provides easy and centralized access to multiple information sources including local Intranet resources (local electronic journals and abstracting and indexing services) and remote subscribed Internet services (electronic journals and online databases) through a single interface. Science server offers tools to create a fast, powerful system with proven scalability and performance, browsing and full-text searching capabilities from a single intuitive web interface. The science Direct supports several platforms including Sun Solaris, Digital Unix, HP Unix, IBM AIX, Unix, IBM AIX, Unix and Windows NT, (Shipman, 1995).

All these softwares need to be integrated so as to present a cohesive environment and to avoid problems with growth and expansion. Some of the important softwares used in a digital library are:

Scanning Software: The process of converting a printed document into computer-processible digital image can be done using a software called "*document imaging system, electronic filing system* etc.

Image Enhancement and Manipulation: The captured images may need manipulation to enhance their quality and effect. Some of the image enhancement features include: filters, total reproduction, colour management, touch, crop, image sharpening, contrast and transparent background.

Integrated Library System: Automation of library services is as important as other services of DL. Rather digital library must be automated in most of its essential function.

Web Servers: A web-based DL requires a web server programme. Many server programs are available for different platforms, each with different features and their cost varying from free to very expensive.

Information Retrieval: Internet search engines may be used on their own and can be connected to an integrated library system or DBMS to provide a fully searchable collection.

Database Management Software: The database management softwares provide structured storage and retrieval facilities to the contents of a digital library. DL uses a variety of database management system ranging from relational and extended relational database management systems to object-oriented database systems. Relational DBMS are most often used for the storage of metadata and indices with attributes that contain pointers to file in a file system. Most of the commercial RDBMS also support storage of binary large objects (BLOB). Object-oriented database systems are slowly gathering acceptance (Lawrence, Giles 1998).

2.5.3 HARDWARE AND SOFTWARE COMPONENTS (CLIENT-SIDE)

Clients are the machines that reside on the user's desks. Therefore, user machine/system should have minimum level of hardware and software to achieve efficient and effective interaction with the DL. Most DL equipped with

an Internet Browser like Internet Explorer or Netscape Navigator as their clients.

2.6 DISTINCTIONS BETWEEN TRADITIONAL LIBRARIES AND DIGITAL LIBRARY

There are some fundamental missions of libraries such as facilitate access to knowledge, information and interaction. Traditional libraries have remained unchanged but the digital libraries have changed the processes, tools and techniques to fulfill these objectives. Some of the changes are represented in the following table:

Table 2.3

Distinctions Between Traditional Libraries and Digital Library

	TRADITIONAL LIBRARIES		DIGITAL LIBRARIES
1.	Slow Evolution and stable.	1.	Highly dynamic, ephemeral and versioned.
2.	Contains mostly individual objects of text and print, generally well defined and categorized, and directly linked with each other.	2.	Contains digital objects not only multimedia but also multisize, not well defined, and fractal.
3.	Organization and structuring of content is flat and contextual metadata is minimal.	3.	Significant internal scaffolding of data structure and richer contextual metadata.
4.	Content more scholarly and outputs of vigorous scholarly validation process.	4.	Not necessarily limited to scholarly content and may not have been through the scientific validation process.
5.	Limited accesses points and centralized management of content and collections.	5.	Virtually unlimited access points; distributed collections, access control and content management mostly characterize digital libraries.
6.	The Physical and Logical organization is usually directly controlled and correlated.	6.	The physical and logical organization could be virtually correlated and controlled.
7.	Slow and usually one way interactions.	7.	Dynamic dialogue type, real time and rich interactions
8.	The philosophy is invariably free and universal access.	8.	Digital Libraries support alternative philosophies: free as well as fee based.

Source: Based on Atkin's summary.

2.7 DIGITAL LIBRARY INITIATIVES IN WORLD

In 1990s, Digital Library concept came into existence. Now, many of the university institution and consortium are making their library digital. These libraries are in different stages of development i.e. preliminary, middle, advanced. Most of developed countries digital libraries are in advance stage. However, in developing countries this concept is taking shape slowly and gradually while some technological advance countries are very fast. But for some it is still a dream. Developed countries are helping their counterparts in developing countries by providing assistance and role-modeling in the formation of Digital Library.

Therefore, for the present study, digital library development in the world can be grouped into three categories, such as Initiative in U.S.A., Initiative in European Commission or Europe, and Initiative in Asia. As mentioned already, there are number of digital libraries in each country across the world. But it is not possible to cover all of them in this study. Moreover, not enough literature is available on the present world scenario of Digital Library. However, this study will discuss the status of few countries (from across the world) and their major digital library initiatives.

2.7.1 DIGITAL LIBRARY INITIATIVE IN UNITED STATES

During the second half of the 1990s, the use of Information Technology in the U.S. and world has grown in big ways. According to U.S. commerce Department report, *The Emerging Digital Economy*[1], in the U.S. alone, the IT industry employed 7.4 million workers by 1998. The traffic on the Internet has doubled every 100 days. On October 10, 1996 President Clinton announced a new "Next Generation Internet" (NGI) initiative to keep America at the cutting-edge of Internet technology. It has 3 basic goals.

1. Connecting about 100 government, academic and industrial labs with end-to-end performance.

[1] See this report on http://ecommerce.gov/emerging.html

2. Research and implementation of technologies to support advanced features such as quality of service and securities reliability etc.
3. The demonstration of advanced applications based on these capabilities.

Like the IT growth in commerce & industry, the Digital Library development has also been growing as well. This is more true about last two or three years.

NSF'S Digital Library-I Initiative:[2]

The DL-1 is a joint four year program, funded by NSF/DARPA/NASA, with $ 24 million budget. It begun in Feb 1995. It's main objective is to advance the methods used to collect store organize and use widely distributed knowledge resources that contain diverse types of information and content stored in a variety of electronic forms. Digital Libraries basically store materials in electronic format and manipulate these collections effectively.

Six-university-led DL-1 projects have been pursuing this goal in partnership with libraries, museums, publishers, schools and computing & communication companies.

University of California at Berkeley's Environmental Planning and Geographic Information Systems (http://elib.cs.berkeley.edu/) is developing tools and technologies to support highly improved models of the "scholarly information life cycle". The goal is to facilitate the move from the current centralized publishing model to a distributed and self-publishing model.

University of California at Santa Barbara's Alexandria Project: Spatially referred Map information (http://www.alexandria.vcsb.edu/adl.html)-The main achievement is an online information system inspired by the Map and Imagery Laboratory (MIL) in the Davidson Library at the University of California, Santa Barbara.

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2 Based on information from the National Science Foundation Project.

Carnegie Mellon University's Infomedia Digital Video Library: This project studies that how multimedia digital libraries can be established and used. This informedia's multimedia library contains over one thousand hours of digital video, audio, images and text (http://www.informedia.cs.cmu.edu).

University of Illinois at urbana-Champaign Federating Repositories of Scientific Literature (http://dli.grainger.uiuc.edu) is developing widely usable Web technology to effectively search technical documents on the Internet. The efforts were concentrated on building an experimental test bed with tons of thousand of full text journals articles from physics engineering and computer science and making these articles available over the www.

University of Michigan's Intelligent Agents for Information Location – This project combines the traditional notions of libraries with contemporary technological capabilities. It includes the open evolving, decentralized advantages of the web and introduces computational mechanisms to tamper its inherent work (http://www.si.umich.edu/umdc/intro.html).

Standard University Interoperation Mechanisms Among Heterogeneous Service (http://walrus.stanford.edu/diglib/) - At the heart of the project is the tested running the "Info Bus" protocols, which provides a uniform way to access a variety of services and information sources through "proxies" acting as interpreters between the Info Bus protocol and the native protocol.

NSF's Digital Library-2 Initiatives (DL-2)[3]

"Digital Library Initiative Phase –2 is a multi agency initiative which seeks to provide leadership in research fundamental to the development of the next generation of digital libraries, to advance the use and us ability of globally distributed, networked information resources, and to encourage existing and new communities to focus on innovative applications areas" (http://www.hiz.nsf.gov).

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3 Source = http://www.dli2.nsf.gov/

It started in 1998 and would complete in 2003. Digital libraries serve as intellectual infrastructure. Hence, this project will gain benefits from the experience and knowledge gained from the DL-1 project. It is main objective to stimulate partnering arrangements, which is necessary to create next-generation operational systems in areas like education, engineering and design, earth and space sciences, biosciences, geography, economics and the sets and Humanities, other objectives of this project are

- To study the potential impact of digital libraries on learning.
- To develop methods whereby audiences can visualize the underlying data to meet their diverse need.
- To develop a broad set of systematically, interoperable documents that can function as part of an open-ended, scalable digital library.

DLT-2 will also support other ongoing collaborations. Collaborators in this project include: a research institute pursuing a long-term study of the history of mechanics (MAX PLANCK INSTITUTE FOR THE HISTORY OF SCIENCE BERLIN), a major art museum with heading collections of ancient art both from Egypt and from the Greco-Roman world (MUSEUM OF FINE ARTS, BOSTON), a professional association supporting scholarly editions in the Humanities (THE MODERN LANGUAGE ASSOCIATION) and its NEW VARIORUM SHAKESPEARE SERIES.

It also has partnership with national Archives and Records Administration, Smithsonian Institution (SI) and Institute of Museum and Library Services (IMLS). Currently, both National Endowment for the Humanities (NEH) and IMLS have their own funding and then have begun to support substantially DL projects for education, research, preservation etc.

The Digital Library Federation (DLF) and Other Developments[4]

Digital Library Federation (DLF) was founded in 1995 to establish the conditions for creating, maintaining, expanding and preserving a distributed

[4] DLF does not come in government framework. While NSF DC-1, 11 are U.S. government funded initiatives. DLF is non-government body and be reach on (http://www.clir.org/diglib/dlthomepage.htm)

collection of digital materials. These collections are accessible to scholars, students, and public. DLF is a leadership organization operating under the umbrella of the *Council on Library and Information Resources (CLIR).* The federation was funded by 12 large university research libraries, Library of Congress, the national Archives and Records Administration, the New York Public Library and the commission on Preservation and Access. The Funding University Libraries are California – Berkeley, Columbia, Cornell, Emory, Harvard, Michigan, Pennsylvania State, Princeton, and Southern California Stanford, Tennessee – Knoxville and Yale. Later on eight more university libraries joined the federation: Carnegie-Mellon, Chicago, Indiana, Minnesota, North Carolina State, Pennsylvania, Texas-Austin and the California Digital Library. The DLF developments can be grouped into four areas:

(i) **Discipline Based Activities:** Where work on social service data archives and the creation of a theological DL.

(ii) **Functional Developments:** It works on access management digital archiving, discovery and retrieval.

(iii) **Digital Library Architecture:** It deals with authorization protocol.

(iv) **Institution Initiative:** Where each institution is taking initiative in their own institution. For example Harvard University in 1998 has come up with $ 10 million dollars of their own money to support Digital Library Initiative.

2.7.2 DIGITAL LIBRARY INITIATIVES IN EUROPE[5]

There are quite a large number of activities being undertaken in European countries with respect to digital libraries – some on a European level, some on a National Level. There are brief descriptions of European Commission Initiative and National Level effort.

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[5] Information obtained from http://ww2.echo.lu/libraries

2.7.2.1 European Commission Funded Project

The Telematics for libraries programme of the European Commission aims to facilitate access to knowledge throughout the European Union while reducing disparities between national systems and practices. European commission has funded more than 100 projects; several of which are described below:

DECOMATE II:[6] The goal of this project is to develop a European digital Library for economics, information resources which is located in different libraries throughout Europe. Successful **Decomate I** covered both copyright- and non-copyright materials of different formats. Whereas Decomate II will include personalized user services plus enhanced techniques for knowledge-navigation. This project is coordinated by Tilburg University Library in the Netherlands, other partners of this project are in Italy, UK, Spain, Belgium and Netherlands.

DEBORA:[7] Debora started in 1999 and is being coordinated by the "*E'cole Nationals des Sciences de Information et des Bibliotheques hyon*" in France with partners from UK, Italy, Portugal and France. This project will provide digital access to books of the Renaissance (14^{th}-16^{th} centuries) and will also develop tools for accessing collections of rare 16^{th} century documents via networks. This includes processing digitizing valuable old books with the images being stored and indexed in an image base accessible via the www.

DIPER:[8] This project offers a testbed for studying the impact of providing fast electronic access to relatively short documents such as *journal articles*. It also elaborates the need in Europe for a central access point where all digitized periodicals can be recorded and from where full text searches of articles can be carried out. The project's participants will contribute to the building up a

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6 Decomate II project, http://www2.ech.lu/libraries/en/projects/decomt2.html
Decomate II website, http://www.bib.uab.es/decomate2

7 Debora Project, http://www2.echo.lu/libraries/en/projeets/debora.html

8 Dieper Project, http://ww2.echo.lu/libraries/en/projects/dieper.html

virtual library by scanning selected journals and linking any existing material. Diaper is coordinated by the Georg August University in Germany and has partners in France, Finland, Denmark, Belgium, Austria, Italy, Greece and Estonia.

DELOS:[9] The Delos working Group is part of the fourteen member European Research Consortium for Informatics and Mathematics, and funded by the European Commission's ESPRIT programme. Its objective is to promote research into further development of digital library technologies – in particular by stimulating research activities in areas which are relevant for efficient and cost-effective development of digital library systems. The Delos working group is also collaborating with the National Science Foundation (NSF) in United States in the field of digital library research with a view to exploring technical, social and economic issues. The Delos group is also active in organizing workshops on various aspects of digital libraries, such as digital libraries for distance learning and audio-visual digital libraries.

2.7.2.2 National Digital Library Initiatives

British Library Digital Library Programme:[10] The British Library's Digital Library Programme aims to establish digital information services based on the content of the British Library's varied collections and develop the capabilities to work with any form of collections. The digital library will consist of documents comprising text, still and moving images sound and both modern and historical element which may be stored in more than one place. The basic idea behind is that the digital collections and services will supplement rather than replace traditional collections.

The Library would consists digital collections which would be built from a number of sources in many way,e.g.

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9 ERCIM Digital Library Initiative/Delos working Group, http://www.iei.pi.chr.it/DELOS

10 British Library Digital Library Programme, http://www.bl.uk/services/ric/diglib/diglib.html

- Through the digitization of some of the Library's existing collections materials (such as ancient texts and manuscripts).
- Through the acquisition of published digital materials (CD-ROMs and sound recordings).
- Through the legal deposit of digital materials published in the UK.

Electronic Libraries Programme:[11] The main aim of the electronic libraries (elib) programme is "to engage the higher education community in the UK" in developing and shaping the implementation of the electronic library.

In the elib phase-I and II 60 projects were funded in the areas of *electronic publishing; digitization and images;* and access to networked resources. In phase III, an attempt has been made to consolidate the experience and knowledge gained from I & II projects. Moreover, it would built a model digital libraries for the future through four main approaches.[12] *hybrid Libraries; Large Scale resource discovery's digital Preservation and development of elib Projects into Services* (Rusbridge, 1998).

Germany:

In Germany, a German digital libraries project has been launched with the objective to achieve efficient access to worldwide information, directly from the scientist's desk, while stimulating structural change in the information and communication process of the scientific community. This project will be completed in 2 phases over the six years with the amount of $35 million.

The German project is based on furthering cooperation with universities, publishing houses, book dealers, learned societies, as well as academies and

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11 elib Programme, http://www.ukoln.ac.uk/services/elib

12 Hybrid libraries aim to integrate new technologies, electronic products and services already in traditional library. Whereas, large scale Resources Discovery approach is that resources should be shared. The four elib project take the form of union catalogues which could be searchable over a network and accessible through a common interface.
However, digital preservation will take place by involvement of strategic, methodological and practical issues involved for the long-term preservation of digital information resources.

research libraries in contrast to the American Digital Libraries project. German digital research library and activities are progressing in five main areas:

- Facilitating more efficient publishing procedures by exploiting electronic means;
- Utilizing electronic technology to advance teaching and learning possibilities;
- Improving content organization retrieval and indexing;
- Facilitating retrieval and content through user interface design; and
- Aspects of ownership, authenticity, pricing and billing.

FRANCE:

Gallica project in France has aim of preparing for remote access to the digital collections of the *Bibliotherque Nationale de France* (BnF) based on digitized printed paper formats, still removing images and sounds. French national library has collections of 30 million digitized pages, out of which, access to *two million* pages in image format are available through *Gallica*. Rather, aim of Gallica is to present a sample of texts from a variety of publications (c.q. monographs, dictionaries, periodicals, rare books) in order to evaluate the conditions under which such digital documents are able to be accessed via networks. Besides, digitized texts, Gallica will also have a collection of some 30,0000 digitized photographs, which will be gathered from public as well as private collections. In addition, the classical Gallica service will be a reference component for researcher offering further digital documents and images via the Internet.

2.7.3 DIGITAL LIBRARY INITIATIVES IN ASIA

This section will attempt to provide a brief overview of the current digital library projects in Asia. There are many countries which are trying to implement information technology in the institution of higher learning and other organization. However this section will discuss only about few countries and their major projects, such as JAPAN, TAIWAN, KOREA and INDIA.

JAPAN

Japan Science and Technology Corporation (JST): This institution is playing vital role in promoting S&T, through research and technology transfer, as well as S&T information dissemination. JST is collecting literature in S&T field from all over the world, and providing database to domestic researchers through online system. It covers 5,172 journals from some 60 countries and also started a service of English language database for Japanese S&T information (JICST-E File). JST has distributed Japan's S&T information in the 3 subject areas – Agriculture, Forestry and Fisheries. In addition, JST provides the following services.

- Advanced Databases (www.bio.info.jst.go.jp)
- Directory Databases (http://www.jst.go.jp)
- Machine Translation Service
- Networking

Nara Institute of Science and Technology (NAIST) – Mandala Library: The Mandala Library is the only operational electronic university library in Japan. NAIST has number of advantages over other universities such as: a well developed high speed campus network; about 1,900 computers distributed on the campus. Therefore, Mandala Library provides services to user which are characterized by:

- a variety of digitized information sources: printed books, journals, CD-ROMs, video.
- high quality colour image data for photographs charts and other colour materials.
- digitized image data for display and also for creating text for full text searching.

NAIST has setup a special copyright committee in 1992; and this committee has been making strenuous efforts to negotiate with publishers. As copyright issues has always been the greatest bottleneck in digital libraries.

Since 1995, in Japan, govt. taking major action towards advancement of universities libraries and other organization in the area of information & communication. The major actions:

- to promote R & D in multimedia electronic libraries at NACSIS and other organizations;
- to provide computers and other facilities to university libraries for improvement in digital information services through networks, and also to encourage them to create electronic library.

TAIWAN:

In Taiwan, universities libraries are executing many projects; such as, the National Taiwan University, Digital Library and Museum Project (http://ntudlm.csie.ntu.edu.twl); the info spring Project of NCTU (ke and change 1998)and Yang-Ming University and so on. These projects, different in nature enhance the quality of web based DC services from several aspects.

The NSC Digital Library: This project is carried out by National Chiao Tung University (NCTU) in Taiwan and supported by the Science and Technology Information Center (STIC), National Science Council (NSC) in Sept. 1998. The prime goal of this project is to establish www-based electronic resources, covering bibliographic database and full-text electronic journals, in order to provide qualified digital information and online service for users (students, researchers, etc.) in Taiwan. For pursuing these goals in an attainable manner, the NSCDC project is divided into two phases. The first phase devotes to the collection and establishment of Web based electronic resources.

- building foreign database and providing access through the mirror site.
- close attention is paid tot he users interfaces of DC systems.

And second phase will develop a DC scheme to integrate foreign and domestic research resources to provide professional information services.

KOREA

Korean government has proceeded with the national digital library since 1997. It is aim to link major public Libraries together on one single nationwide network.

Korea Institute of Industry and Technology Information (KINITI): KINITI is mandated to play significant role in establishing a nationwide information dissemination system to support industrial and technological development in Korea. It objectives are:

- facilitating access to and utilization of information.
- running on-line information system with various search tools.
- increasing public awareness of information services, and
- training information specialists.

KINITI collects a wide variety of information resources such as journals, monographs, reports, catalogues, industrial standards, etc. There are 7,500 journals from 52 countries (partly CD-ROMs) over 7 million patents from 6 countries (mainly CD-ROMs); 55,000 technical reports in Korea and over 70,000 monographs.

INDIA

In, India, the Indira Gandhi National Centre for the Arts (IGNCA) is probably the leader in the area of "digital" development (Chen. 1999). Apart from IGNCA, various institutes, such as Indian Institute of Sciences (IISc), The Indian National Scientific Documentation Centre (INSDOC), Indian Institutes of Technology, Sangeet Natak Akademy, Saraswati Mahal Library have initrated several digital library projects. INSDOC has fairly large number of CD-ROM full text for document delivery in its electronic (digital) library. The full-text CD-ROM products subscribed by the INSDOC include: ADONIS, Business Periodicals ondisc and General Periodicals ondisc. In addition Indira Gandhi National Open University (IGNOU) at Delhi has successfully launched

a number of Web-based online courses in Information Technology under their distant education program.

Recognizing the importance of information technology and its applications, the Government of India has constituted a Task Force on Information Technology.

Indira Gandhi National Centre for the Arts (INGCA): INGCA is a government promoted autonomous trust under the Ministry of Human Resources Development, Government of India, and was established in 1985. Since 1994 a Cultural Informatics Lab (CIL) was established under a UNDP/UNESCO assisted project for the development of interactive Multimedia Documentation and in-depth analysis of cultural information through CD-ROM publications. Over a dozen projects have been initiated requiring a multi-disciplinary approaches of national and international scholars, computer scientists and graphic designers. IGNCA's Multimedia Lab (CIL) integrates modern technology to help further the mandate of IGNCA as the designated nodal agency for all matters related to art, humanities and cultural heritage. Its multimedia applications in technologies are:

- Silicon Graphic – 3D Graphic Station; Image & Video Editing, Modeling and Animation, Winter-Project Development.
- Power Mac – Graphic Designing, Image Editing
- Kodak Imaging Workstation (PIW 4220) – High Quality Digitization Solution for Slides, microfilms and microfiche.

National Centre for Science Formation (NCSI): The University Grants Commission (UGC) of the Government of Indi, in 1982 envisaged the development and establishment of regional library centers on various subjects/disciplines which would strengthen information support for research and teaching in the Indian Universities and Colleges. Indian Institute of Science (IISc) in Banglore was given the responsibility of establishment of UGC *National Centre* for Science Information (NCSI) in 1983. This center is fully funded by the UGC. NSCI's services can be broadly classified into three types:

(1) **Database Search Service**

- Current Information Services:
  - Current Awarencss Service (CAS) in various disciplines
  - Contents of Pcriodicals in Science and Technology (COPSAT)
  - Contents of Pcriodicals in Science and Technology (COPSMED)
- Online and Information Services – CD-ROM Database Search Services (CORS), Online Search Service (OSS) and Factual Data Search Service (FDS)

(2) **Document Delivery Service**

(3) **Network Information Service** – This includes web services, Internet Search Service, Infowatch (an e-letter), LIS-Forum (an-e-mail based discussion forum)and CD-ROM database. Some of the databases are AGRIS, CAB, COMPENDEX, BIOSIS, FINDEX, MATHSCI, MEDLINE, INSPEC etc. and NISC. They receive over 1000 e-journals through the World Wide Web (www). In addition have access to Silver Platter's ERL databases, including Biological Abstracts (1995) MEDLINE (1994).

2.8 ISSUES/CHALLENGES BEFORE DIGITAL LIBRARY DEVELOPMENT:

The potential for the development of digital libraries to support life-long learning in any place any time is great, however, there are still many issues, that must be addressed. Some of the issues are discussed below:

Technical Support: Computers and the software that run by digital libraries are not yet intuitive and the networks that connect them are subject to slow-down. Considering the fact that technological infrastructure is running on very fast pace of changing/renovating the system. The latest technological innovation can cost more than the investment in phase I development (Garrett, 1993).

Besides, Librarians, users and instructors must all have some level of technological know-how in order to function optimally in a virtual

environment. This re-training requires a serious investment in both time and money.

Copyright: If libraries do begin to systematically collect digital information on a large scale, the provision of effective access could be questionable. In fact, copyright could end up preventing libraries from providing open access to the digital information they collect. Therefore, copyright must be managed so that digital information can be created and distributed throughout "digital libraries". Otherwise, copyright could become an insurmountable barrier to the development of digital collections. There is an increasing uneasiness among members of the library community. Copyright changes will adversely affect the ability of librarian to provide digital collections and services. An International Publishers copyright Council says that many national and regional libraries contemplate digitizing their print collections to facilitate a virtual library that can provide service to patrons at remote locations and facilitate resource-sharing. Such a concept will destroy not only the incentive to create new copyrighted works, but the revenue from existing works that provides the investment in new works by author and publishers (I.P.C.C. 96).

Under these restrictive conditions digital libraries will not be able to satisfy many of the imperative of information 'anywhere, anytime'.

Preservation: Preservation of digital material, both in terms of storage and access to content regardless of format, is also problematic (Raitt, 1999). Media used to store digital materials becomes technologically obsolete much faster than paper. It is continually replaced by better technology. Thus, libraries will need to constantly migrate digital material to new storage media that will cause formatting difficulties. The cost of such migration is unknown and there is no guarantee that future generations will have the funds to do this.

Economic Issue: Information has never really been free. There is always cost in its creation, its production, and its dissemination. Digital Libraries introduce new and uncertain economic realities and relationships into libraries. Where

the costs of accessing information were once hidden to "patrons" in the digital era and now "customers" would be required to pay for access to digital service and collections (Kunny, 1999). A major assumption of the information age, is that information will be available to all. However, the TVLIP final report revealed that "building DLs will be a costly and lengthy process" and making additional funds available for this content will not be a trivial process. The harsh economic realities are that digital collection development involves heavy costs for implementation, licensing, training, promotion and the development and support of a technical infrastructure. (TULIP, 1996).

Finally, a Digital Library is more like a "knowledge Center" where, a complex system of professionals whose expertise supports access to information, acts as an intermediary to a variety of digital and other sources. Therefore, all these issues which discussed above are the bottleneck in the development of DL. There is urgent need to solve these problems.

Chapter 3

Review of Literature and Research Methodology

An attempt has been made to observe and analyse the studies related to cost. Therefore, this chapter has been divided into two main sections. First section deals with theoretical studies, and also emphasizes on empirical studies. The second section deals with the methodology of the present study.

SECTION I

3.1 OVERVIEW OF LITERATURE

Cost studies can be divided into two broad categories (a) Theoretical Studies – discussing the cost structure, concepts and importance of cost analysis (b) Empirical Studies – analyzing the cost estimation of using different media i.e. computers, T.V. in education.

Several studies relating to cost analysis in education occupy substantial space in the literature where cost analysis and its concepts have been discussed thoroughly by several economist. However, cost analysis particularly relating to information technology does not figure out prominently in the existing literature. Therefore, a few studies relating to "new media" in education have been discussed in this chapter to derive some basic idea of cost structure of new information and communication technologies.

3.1.1 THEORETICAL STUDIES

This section discusses the cost analysis and its components. There is ample literature available on cost structure and concepts which offers different definitions of cost analysis. Thus cost analysis may vary from study to study. Cost analysis helps in find out the wastage in any system, and leads to increases in efficiency. In short, cost analysis is a process of gathering and organizing information about the costs of a programme, and provides a break up of costs (Levin, 1978). Cost analysis can be divided into two groups (i) cost-benefit analysis (CBA) (ii) cost effective analysis (CEA). CBA is a technique which attempts to set out and evaluate the cost and benefits of investment projects. It helps to decide whether or not the project should be undertaken. This technique could be used to assess, evaluate and forecast about any project.

On the other hand, CEA evaluates the effectiveness of any project which is non-economic in nature. Therefore, CEA relates costs to ordinary measures of (educational) outcome. Effectiveness is the degree to which an organization approximates to achieving its goals. Generally, cost analysis always takes into account the effectiveness perspective.

There are several costs which should be taken into account while measuring cost of a system. Among these, fixed, variable and opportunity costs are the main costs. These are all economic costs, and not accounting costs. Further, various kind of costs can be computed while analyzing the cost of a system. Unit cost is an important cost which shows how effectively and efficiently are the available resources used. This analysis can be used to find out the losses due to wastage and non productivity of the system.

Schramm (1967) has elaborated the importance and difficulty of costs while estimating the costs of new media. He mentioned that difficulty in costing arises in the fact-finding, as there is often a difference between budgetary costs and total costs. Therefore, media's costs should be broken down in the traditional ways as: (a) production (including administration), (b) transmission (a distribution), and (c) reception. Again, he highlighted the distinction between fixed and variable cost. Fixed costs are those that are insensitive to an increase in the number of students. Variable costs of programme production, administration and transmission normally vary with the number of students or with the number of programme hours produced and distributed. Reception costs could also be divided into fixed and variable costs.

Orivel (1975) defines the cost structure. He categorizes the cost into two groups, (i) fixed cost (ii) variable cost. However, there were certain costs which could not be placed in any category, as relative cost of each stage in the process varies considerably according to the technical medium used (Thus transmission cost are generally higher, than production cost, for television than for radio). He emphasized that the economic classification of costs makes a distinction as to whether they are variable or invariable. It has been seen that certain variable

costs are fixed costs, i.e. they are incurred once and for all, or at least at considerable intervals, whereas other are recurring, i.e. they are repeated from period to period (maintenance, staff salaries). He insisted that not only total units, but unit costs should also be calculated. The two most useful categories of unit costs are cost per hour of contact and cost per students in the case of new educational media and they could be brought together to form a combined index: cost per student hour.

Fielden and Pearson (1978) emphasized on the value of cost analysis for a project to arrive at wastage and inefficiency factors. In these circumstances, cost analysis could help to understand the various cost components and would explain effectively the categorization and importance of cost functions. Therefore, cost analysis could be a powerful tool to achieve these goals.

Jamison, Klees and Wells (1978) discussed the methodologies which were appropriate for cost analysis of an educational system. Therefore, primary objective of this report was the development of the appropriate methodological approaches which could analyse the cost information accurately. They elaborated that cost analysis was affected greatly with the initial collection and organization of the relevant cost data. Therefore, it is important for cost analyst to gather historical cost information as well as information on the amount of physical resources purchased in each category and the period associated with the expenditure. The number of users were an important component which could affect the structure of a system. After having discussed the cost functions and they elaborated its properties in detail. At last, they explained that annualization of the expenditure on capital equipment was important in order to construct a cost function.

Eicher (1982) mentioned that since it has led to a belief that educational methods using modern technologies materials must normally have fixed costs proportionally higher than those of traditional education and consequently, they could lead to much bigger economies of scale. Thus, it has become apparent that economic analysis could and should help throw light on the problems that

educational system faces today. Since educational system using modern technological media is in general, complicated to organize. It is necessary to reach an opinion, what is to be measured and thus, the different types of costs to be ascertained.

Psacharopoulos and Woodhall (1985) emphasized on the importance of establishing appropriate method[1] of measuring the cost. Furthermore, they elaborated the importance and components of cost analysis in new educational media and argued that if the goal is to understand the determinants of costs, in that case, cost analysis is important. For instance, cost functions could help to throw light on the way total or average costs change in relation to the size of an institution and if opportunity cost is to be estimated with any degree of accuracy, *shadow price*[2] may have to be used to measure the true economic value of resources when market prices are distorted. In practice, the distinction between capital and recurrent expenditure on education is difficult to apply. In common, capital expense includes the initial purchase of books and furniture and subsequent replacements (together with repairs and maintenances) as a recurrent cost. Rather than treating the purchase of a major item of equipment as a capital cost in a single year, however, it may be more helpful to calculate the annualized value of capital expenditure by calculating *depreciation*.[3] While defining marginal and average cost, they wrote that the costs of new media were often being underestimated as unrealistic assumptions were made about economies of scale. Therefore, it was necessary to distinguish between average and marginal costs, and also between fixed and variable costs. Average cost, often called 'unit cost', simply represents total cost divided by the total number

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1 The World Bank, UNESCO, and IIEP have together developed methodological guidelines for the estimation of costs in education.

2 The opportunities cost to a society of engaging in some economic activity. It is a concept applied to situations where actual prices can not be charged. More generally, shadow prices are used in valuing any item which is implicitly rationed or constrained in some way. Shadow prices can be derived using linear programming techniques, and can be used in cost-benefit analysis.

3 This is reduction in value of an asset through wear and tear. The purpose of depreciation provisions in accounting is to ensure that the cost of the flow of services provided by capital assets is met in the price of the company's products. In practice, depreciation provisions are treated as part of the net cash flow of a business and are used to repay loans, to purchase other fixed assets.

of students. The marginal cost of one unit of output in the extra expenditure incurred when one additional unit is produced. They revealed that some economists prefer the term incremental cost, rather than marginal costs. And in practice, it is often extremely difficult to identify marginal costs, but the concept is nevertheless important when expanding the system, whereas average costs indicate the amount of money devoted to each student in the system. Thus, the concept of a cost function could be used to investigate the relationship between average and marginal costs. However, the cost function is partly determined by relationship between fixed and variable costs.

Cohn and Elchanan (1990) elaborated the cost concept in detail. They revealed that the meaning of 'cost' in economics differs in two important respects from conventional pattern. First, economic costs include all opportunity costs; second, and perhaps more importantly, economic cost are the minimum costs necessary to produce a given level of output. Furthermore, the costs of education include both direct costs and indirect costs. Besides, there are some other costs which are borne by students such as transportation costs, books costs etc. They discussed that the costs of implicit rent and depreciation were another example of economic costs that must be imputed. Here, implicit rent represents forgone opportunities of renting school buildings, grounds and equipment for non-educational uses, while depreciation reflects the wear and tear of physical assets owned by the school system or any institution. Both represent current educational costs. Authors emphasized that implicit rent and depreciation should be computed as per objective of the study, as including the two together or only one of the two depend upon the purposes for which these costs are computed.

Finally, it can be assumed that cost analysis is important tool in estimating the budget for any project where it explains the categorization of cost effectively (Coombs and Hallak, 1987). Both techniques (cost benefit analysis and cost effectiveness analysis) of cost analysis are important as each technique has its own special traits and limitations. For instance, cost

effectiveness has its own limitations as concept of effectiveness is broader than the concept of benefits or economic advantage. Moreover concept of cost analysis could differ from study to study because cost components require different kind of categorization according to type and need of the system for which has been carried out. In some case, cost components could be used interchangeably as no international boundaries have been set. Therefore every cost analysis is unique in its own way. Therefore, while differentiating the costs great care should be taken.

3.1.2 EMPIRICAL STUDIES

In this section, two types of empirical studies have been discussed. One, which discusses the costs and its components in educational media. Second, the studies which are related to information technology and higher learning. Therefore, studies can be divided into two subsection (i) studies on new educational media (ii) studies on information technology.

3.1.2.1 Studies on New Educational Media

Jamison (1974) carried out a study on 'Nicaraguan Radio Mathematics Project' (RMP). Objective of the study was to do the assessment of cost of RMP and to analyze their projected cost. Therefore, both historical and projected cost methods had been used to calculate the cost components. Cost components for the RMP fall into four categories – central project, program preparation, transmission and reception site costs. A cost function for the RMP had been constructed to give annualized total cost. The cost function:

$$TC = F + V_N N + V_h h$$

Where F = annualized starting costs + project administration cost

V_N = the variable cost per student

V_h = the variable cost per hour of programming broadcast

Three basic points emerged from this analysis of RMP in Nicaragua. In the first place, the intensive efforts put into program preparation suggest that, unless careful effort is undertaken to make these program available to many

users, the cost per student of program production would be extremely high. Secondly, cost of per student hour were exceptionally high and suggested that careful experimentation with less frequent and less intensive training could be useful to cutdown the expenses. They concluded by saying that it appears that reception site could be reduced substantially and emphasis should be made on evaluation of effectiveness of RMP.

Chan (1976) carried out a study of the costs of introducing a reform in primary education in Ivory Coast, Africa. Main objective of the study was to calculate the costs of television as a medium of instruction in primary education so that a comparison could be made between traditional approach and the new technical approach (T.V.) on the basis of costs and effectiveness. Author had divided cost into three categories (i) Reception Cost – which was sum of the costs of television sets and related items; the cost of the power supply; and the cost of maintenance. (ii) Production and broadcasting costs which include the cost of equipment to prepare teaching material and (iii) total cost of a new center and share ascribed to television production buildings and studio. However, other costs were also calculated such as training and re-training of teachers. Finally, all these costs were divided into investment and operating cost. Results revealed that per unit cost of new media was lower than traditional media.

Gilbert and Honaco (1978) carried out a study on the 'Kent Mathematics Project' (KMP) in UK enabling teachers to devise individualized mathematics course for students to encourage independent learning. The tasks were multimedia where teachers prepared audio tapes, games and worksheets for individual pupil. Researcher estimated the costs of KMP where seventy schools were involved in this projects and also to know whether this project would be able to adopt others. The costs were divided into different groups: such as salaries of professional staff and support staff; equipment and supplies; and cost of accommodation. Furthermore, average cost per pupil were also calculated as 35,000 Kent children expected to become involved in the scheme.

The main conclusion of this study was that development cost of this system is £ 340,000 and 90 percent of this represents marginal expenditure. The steady average cost over an assumed life of ten years would be around £ 67,000 a year which might be reduced by royalties to be received from the sale of published material. The costs to another project could be significantly lower, but this would depend on the prices charged for the published material.

Kaur and Nandan (2000) carried out a study to estimate the cost of computerization in Bhai Gurdas Library of Guru Nanak Dev University, Amritsar had been chosen for the purpose. This has introduced facilities of computers in library services in 1993. The cost-components have been divided into two categories (i) Non-recurring cost which constitutes the cost of computer systems comprising printers, software and other equipments (ii) Recurring costs which include salaries paid to the staff, telephone charge, consumable item and annual maintenance cost @ 10 per cent of equipment cost. Cost information had been collected for library. The study concluded that use of information and communication technologies in Bhai Gurdas Library has increased the efficiency of the library, and cost estimation of computerization of library activity showed that further transformation of this library into an information center could be made.

3.1.2.2 Studies on Information Technology

Tearle, Davis and Birbeck (1998) carried out a study for Higher Education Funding Council for England. The study had been done in 1996. The objective of the study was to investigate the role of information technology (IT) assisted teaching and learning in higher education in England. Six case studies were captured at six universities across England. Each case study focused on a course where IT was used to assist teaching and learning. Staff and students were interviewed. Outcome of the study showed that IT assures quality for higher order skills in a variety of contexts and IT can play a central part in every sphere of system. Besides, IT also provides easy access to wide

information and also help in management of data. Even, staff were benefited from IT.

Hayes (1999) provided a descriptive analysis of the economies of digital libraries, with emphasis on the nature of the markets (how workforce are engage in different industries) and values to users. This study was conducted in many developed and developing countries (countries had been selected on the basis of the national economy), which were divided into two categories. A model propounded by Porat (1977) had been used to define the economy of respective countries i.e. non-information and information industry. The outcome of the study was the Internet and World Wide Web are growing so rapidly that it is impossible to pin down. He mentioned that many of the economic facts were observed by subsidy, however, it could be said, given the major capital investment in telecommunication infrastructure, computer and software, the costs of access to information on the internet bears almost no relationship to the level of use. (It was fascinating to find Finland, with a population $1/60^{th}$ that of United States, 25% greater in the number of Internet hosts per person). The study concluded that average cost of television was 3,713 Francs. Author also said that these costs could be lower, if some progress could be made by improving the technology of solar cell.

Breen, Rosanna, Lindsay, Roger, Jenkins Alen and Smith Pele (2000) carried out a study to investigate how students use and think about information and communication technologies (ICT) in the context of learning at University. Therefore Oxford Brooke University had been selected and all students from three courses were chosen for the study for the year of 1996. The research methodology included various tools like questionnaire, qualitative data and diary method were used to collect information. The result of study shows that average age of the sample was 21.3 year. Desktop computers are consistently more popular than laptops but the number of students choosing to purchase laptop seems to be increasing, but this difference has not yet reached significance. The most striking finding was that PC-based learning has become

a central feature of the student experience. Average time spent using Personal Computer (PCs) by experienced computer user is almost 2 hours per day. Students have developed positive attitudes to Information and Communication Technology (ICT) as a result of using high-quality CD-ROMs which are relevant to their study needs.

After having discussed the cost and information technology, it can be said that incorporation of IT in higher education would change the facet of learning. Increasing cost of technology could be minimized with increased number of users. Consequently, an assumption can be made about IT that it has been welcomed by students, faculty and staff as they are bringing efficiency and quality in the work area. Therefore, these technology could be used while considering the fact that initial costs are high.

SECTION II

3.2 METHODOLOGY

3.2.1 AREA OF STUDY

The area of study is Central library of IIT Delhi, now which is known as "Digital Library". IIT, Delhi's library system supports the teaching, research and development programs of the institute with the help of one central library and 17 Department libraries. Central library of IITD is the main constituent part of the library system, which is one of the most modern academic library in India. All the students, faculty, employers of the institute are entitled to take use of its services and facilities. In addition to all the conventional services of an academic library, it also provides modern services such as access to CD-ROM databases at institute LAN, video viewing facilities and on-line access to electronic journals. More than 1400 e-journals can be accessed at institute LAN. The book collection of over 1.30 lacs is available on OPAC which may also be accessed on Internet.[4]

[4] Detailed information about all technologies terms have been provided in Appendices.

Digital library activities are divided into two groups (i) automation of In-house operation (ii) Net-Enabled services. This section includes various divisional activities which are given below:

Acquisition Division: The division is responsible for procurement of all kinds of print documents material. After the broad allocation of library budget between journals, books and non-print material it maintains a close liaison with Departments/Centres for procurement of books on payment, exchange, sending regular feedback to Departments/Centre on issue like expenditure incurred information about new titles, book, fairs etc. The LIBSYS software package has been successfully implemented for the acquisition of books. Now, records are being maintained in computerized form. In acquisition staff strength is four including the head of division and around 5 computers have been provided with printer facility.

Serial Division: The serial division of central library provides serial related services to its users. This includes print as well as online full text journals, and CD-ROM databases. All the registered library members (4000) are the users. It has more than 80,000 bound volumes of journals and receives about 20,000 loose issues of journals every year. The total staff strength of this division is ten which includes the head of this division, professional and non-professional staff. Number of computers for the serial division is seven with several other hardware components.

Reader's Services Division: This division deals with user's service which provides facilities to readers of library. These activities are registration and renewal of membership of all users which is full computerized, called as bar-coding service. It's provide reference service, circulation of books/journals (issue and return), money collection for lost books by the library members. Furthermore, it helps the users in searching books/journals through on-line public access catalogue (OPAC) with search facility by author, title, publisher, subject, keyword, accession number, ISBN members, etc. which is

computerized catalogue of books/other materials. It also coordinates the task of bar-coding[5] of library books.

All activities mentioned above are computerized in the division and its staff strength is nine. Number of computers are thirteen (which includes the terminals-computers, which are used for OPAC services). Apart from this, scanner and other equipments have also provided.

Processing Division: The processing of the books and other documents involve various kinds of activities that are undertaken to make the document ready for readers. With the help of LIBSYS software package efforts are being made by the division to implement the cataloguing module and various additional activities are being completed by this software. In this division, staff strength for computer activities are two.

Computer Application Division: Computer application division is handing activities related to computing and network (upgradation and maintenance). Some of the main activities are:

- Maintenance of library database consisting of 1,30,000 bibliographic records;
- Train the library staff in use of computer for various computer-oriented projects;
- Train students in usage of digitized collections accessible through internet;
- Facilitate CD-ROM based search services;
- Facilitate web-based service such e-journals subscribed by IITD and other on-line material; and
- Providing old journals in digitized form through LAN and WAN

However, network enabled services are divided into three group which is being developed, and maintained by CAD.

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5 Bar-coding is a activity where books and other materials get a unique bar-coded sticker, pasted on the books. This bar-coded stickers contain all informations related to book and generated by computer which makes it very effective. This information is used at the time of issuing book to user.

Network-Based CD ROM Search Services: This library offers network-based search services through a CDNET system, comprising of 28 CD drives, a Compaq prosignia CD server, and a CD sharing application enabling access to CD ROM databases on the campus LAN. The CD networking system can be accessed anywhere on the campus Intranet, using an Internet browser. The access to CD-ROM databases is also extended to researches from other institution on payment basis. The library subscribes 14 CD ROM databases, which are mentioned below:

Access to Digitized Collections: The library have provided access to several new web-based full text electronic journals. The library has signed license agreements with electronic publishers after carrying out negotiations so as to get maximum benefit for the users. Thc license agreement with the *Elsevier Science* publisher is signed whereby user will be able to access 1100 journals on the Science Direct Site with download options without any restrictions. In all about 1400 journals can be accessed full-text through the sites of the following e-publishers:

Digitization of Old Journals: The library has completed the first phase of digitization of old fragile back volume of journals, some of them date back to last decade of 19^{th} century. The first phase of the project completed of scanning 25,000 volumes journals. Therefore, library has saved 675 sq. feet of shelving area.

This facilities is being used for other purpose as well as laser prints of the articles from the image database is supplied on request at a reasonable cost to the libraries and individuals.

Computer Applicaticn Division has staff strength of three persons. Sometime, manpower had hired on daily basis. Number of latest information technology instruments have purchased by this division.

3.2.2 RESEARCH QUESTIONS

This proposed study would seek to answer following question:

Q.1What role information technology can play in educational sector, specially in academic services (Library)?

Q.2 What are the various fixed and variable costs in digital library?

Q.3 What are the determinants of development costs of various modules of in-house Operation in digital library?

Q.4 What are the development costs of Net-Enabled services in a digital Library of IITD?

3.2.3 SAMPLE

The Indian Institute of Technology (IIT), Delhi has been selected for the purpose of study. The management of the central library of IITD was approached for study. This study is based on a case-study approach[6] to calculate the cost of digital library of IIT, Delhi. Different division of the library are also included which are involved in the process of digitization of library. Each division has been considered as unit for the purpose of study. Analysis of cost is limited to only those divisions, which are using information technology (computers) in this activity fully or partly. Costs of traditional (conventional) library's activities are not included in the study as these division do not take part in building up a digital library.

3.2.4 PERIOD OF STUDY

The central library of IIT was established in 1969. However, the period of the study spreads over the period 1998-2001, as concept of digital library in IITD came in the year 1998 only. However, some activities were also going on to some level but impact of new technologies could not be felt to this extent.

3.2.5 SOURCES OF DATA

Financial records of Central Library, IITD, from 1997-2001 are the major source of information (cost) for this study. Along with this, some

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[6] Case study is "a technique in which as individual or group, institution or phenomenon is recognized as a unit of study and various aspects of the unit are studied deeply. As unit of study may be an institution, an individual or an entire community. It aims at studying everything about something, rather than something about everything

exhaustive interviews were also held to know the functioning & cost components of digital library. Unpublished sources like accounts records, user record from different division were also used. Report on library activity, brochures were also taped to collect information. Even published sources were also consulted to examine accuracy and historical background of the cost structures and digital library.

Moreover, seminar proceedings from international and national agencies dealing with same, were also consulted.

3.2.6 COST CATEGORIZATION IN THE CONTEXT OF PRESENT STUDY

COST: It is defined as the value which must be given up to acquire/achieve an item. We can have broadly the following categories of the costs.

ECONOMIC COST

This classification of cost distinguishes the costs on the basis of the dimension of operation. Within each of the technical operation it is possible to divide the total cost in terms of fixed and variable costs. For instance, fixed cost at the development stage includes the purchase of equipments (computers, printers, scanner etc.) and salaries of the staff whereas, variable costs include cost of Internet, electricity cost, maintenance cost and subscription of journals.

Fixed Cost

Such costs are incurred once and for all or atleast for a considerably long period of time. These costs have no relationship with the size of the activity. For example, a digital library has certain fixed costs which have no relationship with size of library and these fixed costs have to be incurred before any number of user come to the library. These costs are referred as infrastructural costs. In a digital library, fixed cost may be high due to highly advanced equipments such as computers, servers, printers, scanner. However, building cost may not be included in fixed

cost in the case of digital library as it is only complimentary to conventional library.

Variable Costs

Variables costs vary with the number of users and output of the activity such as raw-material costs, power etc. These costs are also known as operating cost or prime costs. Maintenance cost, raw-material, subscription of e-journals, electricity, internet cost and salaries of the staff (because manpower is involved in the process of digitization of library) have been categorized as variable cost in this study. Thus, all variable cost are monthly expenditure by the institution and vary with the size of users.

UNIT COST

Cost analysis may be concerned with the total costs of an activity or with unit costs. Unit cost measures the cost of one student or one subdivision of that particular activity. Unit cost can be measured by dividing total expenditure divided by number of students (AC = TC/N). This gives the average cost per student. Whereas, it is fairly obvious that total costs increase with scale, it is not obvious whether average cost rise, fall or are unaffected by the level of activity. Where average cost falls as output increases, one can assume of existence of economic of scale.

3.2.7 COST CALCULATIONS, ADJUSTMENTS & ATTRIBUTIONS:

The cost analysis is based on cost information provided by central library, IIT Delhi. These cost estimations needed adjustments and attribution in some cases. Therefore, we have made several adjustments and attributions due to lack of appropriate cost information. The study has taken great care while adjusting these costs.

First of all, some of the cost information has been provided in US dollar as most of the hardware devices have been imported. Therefore, current dollar exchange has been used to know the value in Indian currency. While

calculating the fixed cost, capital cost has been used as annualized capital cost which has been calculated by depreciating[7] the wear and tear of equipments. Initially, digital library required several highly advanced equipments, such as computer, server, scanner, printer, software and networking components. These all have been considered as fixed cost in the present study. Therefore, annualized capital cost (fixed cost) has been taken into account while calculating total fixed cost of all divisions. We assumed that equipment/ hardware devices would be utilized for several years. Therefore, the study has assumed the life span (n) for software and all hardware devices as literature does not sheds any light on this issue or not specific life span has been used for a particular equipment by other researchers. Life span (n) of software and hardware for this study as follows:

Computer: 3 years; Server- 5 years; CD-ROM Tower – 8 years; Switch- 10 years; Hub- 10 years; UPS systems, Printer, Scanner- 3 years; Networking- 5 years; CD-ROM- 13 years; Terminal (computer) 5 years.

Hence, capital cost was annualized for different years by taking capital recovery factor into consideration at the rate of 6 per cent interest per annum. Annualized fixed cost has been calculated on the basis of 6 per cent rate of interest because education is a merit good. Therefore, social rate of interest could be applied. This rate of interest is also used by some of the public projects of the Planning Commission.

Electricity cost provided by central library, also needed some adjustments as lumpsum data (cost of electricity) had been provided. Library activities have been divided into seven divisions, because of this fact division

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[7] Jamison, Klee and Wells (1976) had provided a depreciation formula to calculate annualize cost.

$$\text{Annualized Capital Cost} = \frac{r(1+r)^n}{(1+r)^n - 1} \times \text{capital cost}$$

Where, w = rate of interest
n = life time of the object

of electricity cost was difficult to made. Therefore, electricity cost has been divided into only two groups (i) electricity cost of automation of In-house operations (ii) electricity cost of Net-Enabled services. This division has been made by taking their activity and space factor (as bigger area require more light, fan and cooling system) into consideration.

Internet cost information was other important cost which required adjustments and attributions. Internet cost was borne by the institution not by library itself. Even, all cabling and other devices have been fixed in entire institution (IITD) and library is one of them. Cost of networking (which had been fixed outside the library premises) has not been included as it was not related to digitization of library. But Internet cost is directly related to digital library as Internet is an important tool to access and spread information. Therefore, this absolute cost has been summed up in the cost calculation.

Among other components, staff salary components have been divided into two categories (a) Administrative Staff Salary - The salary paid to the staff who are engaged in administrative jobs (decision making, head of the library). (b) Technical Salary - The salary paid to the staff who are fully engaged in the digitization process or technically helping. Cost of old furniture & fixtures ones have been computed on the basis of new furniture. As in some cases, furniture used by library for digitization activity was old. Cost of furniture has been depreciated keeping the life span into consideration. The digital library is using various software, though, LIBSYS software is main software which is used for automation of In-house operations. To calculate the software cost for each division, software cost has been divided by number of divisions, because all divisions were using software equally. Besides, cost of software's maintenance has also been calculated by above said method.

On the other hand, number of users consist of students, the faculty and library staff. Researcher has assumed that all of the students, faculty and library staff are using the digital library facilities.

CHART-1

STRUCTURE OF DIGITAL LIBRARY

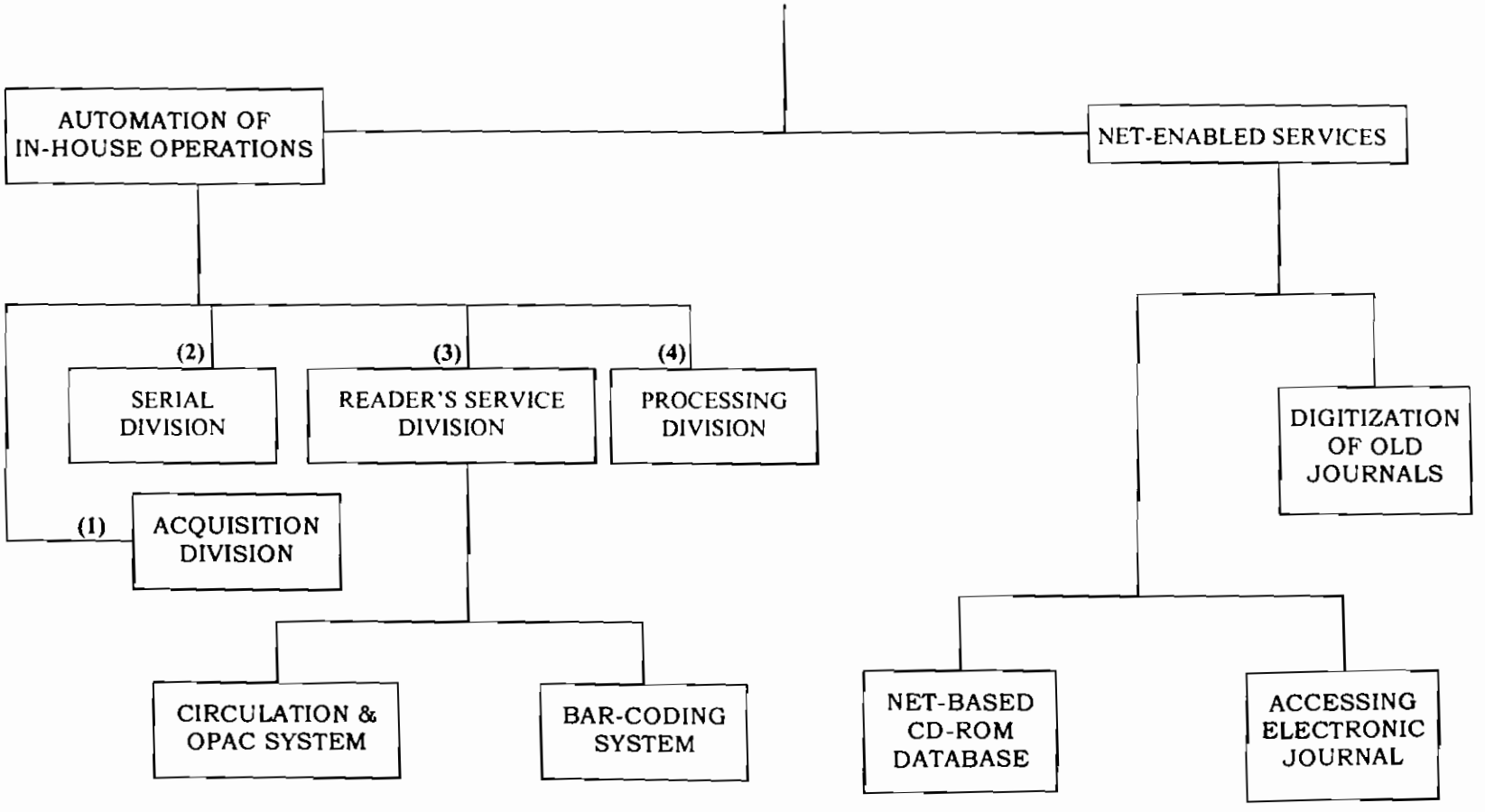
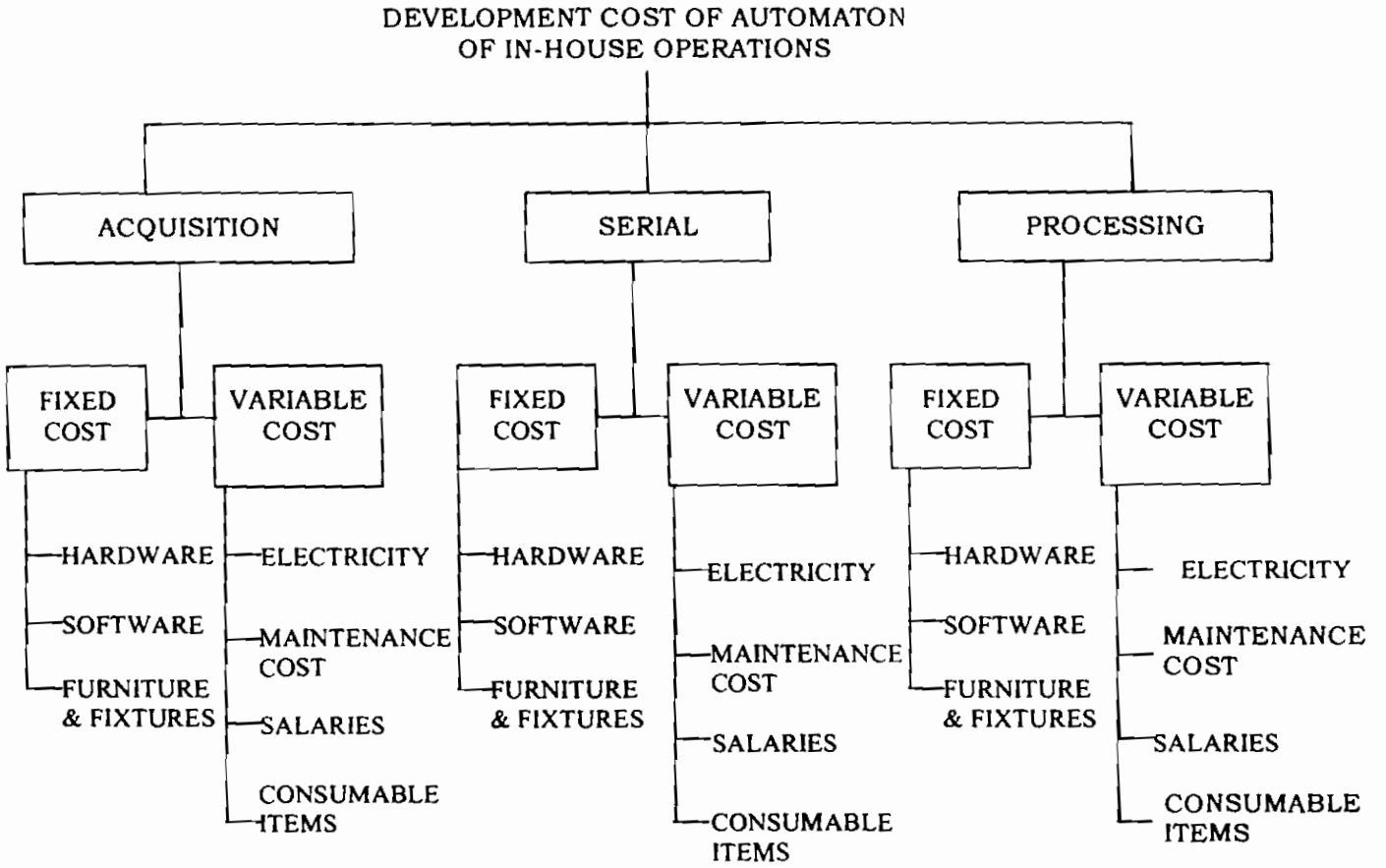


CHART-2



Contd...

CHART-3

DEVELOPMENT COST OF AUTOMATION OF READER'S SERVICE DIVISION

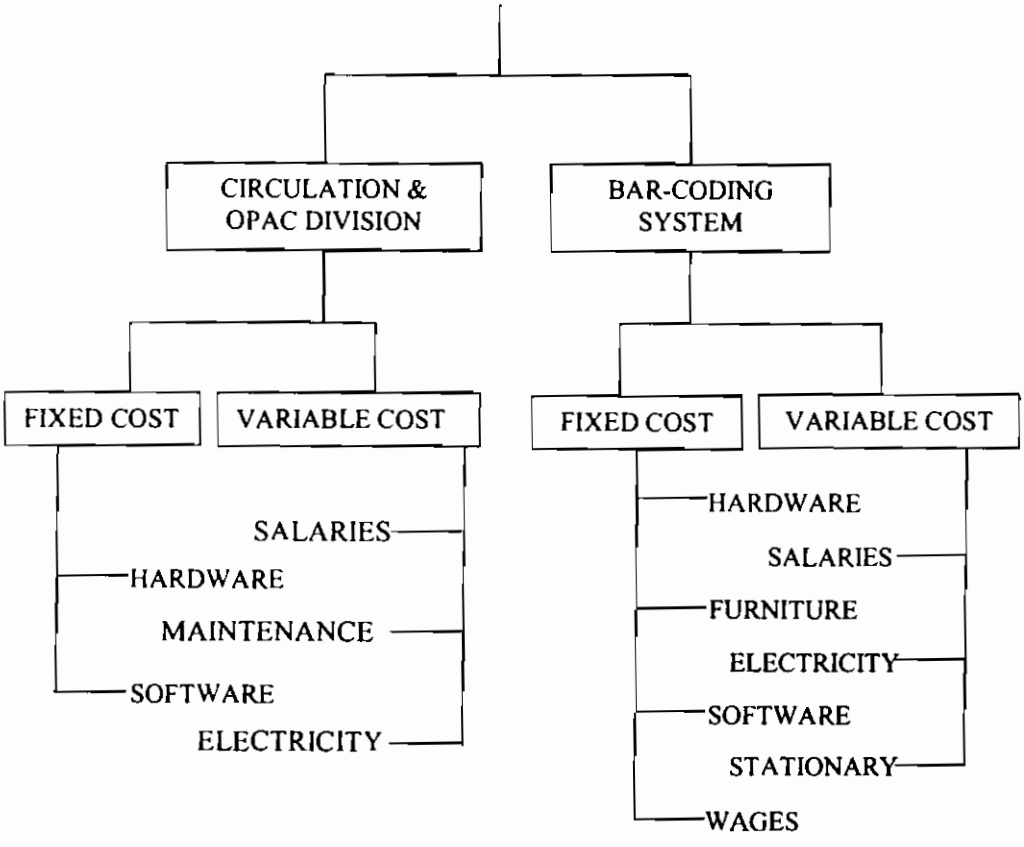
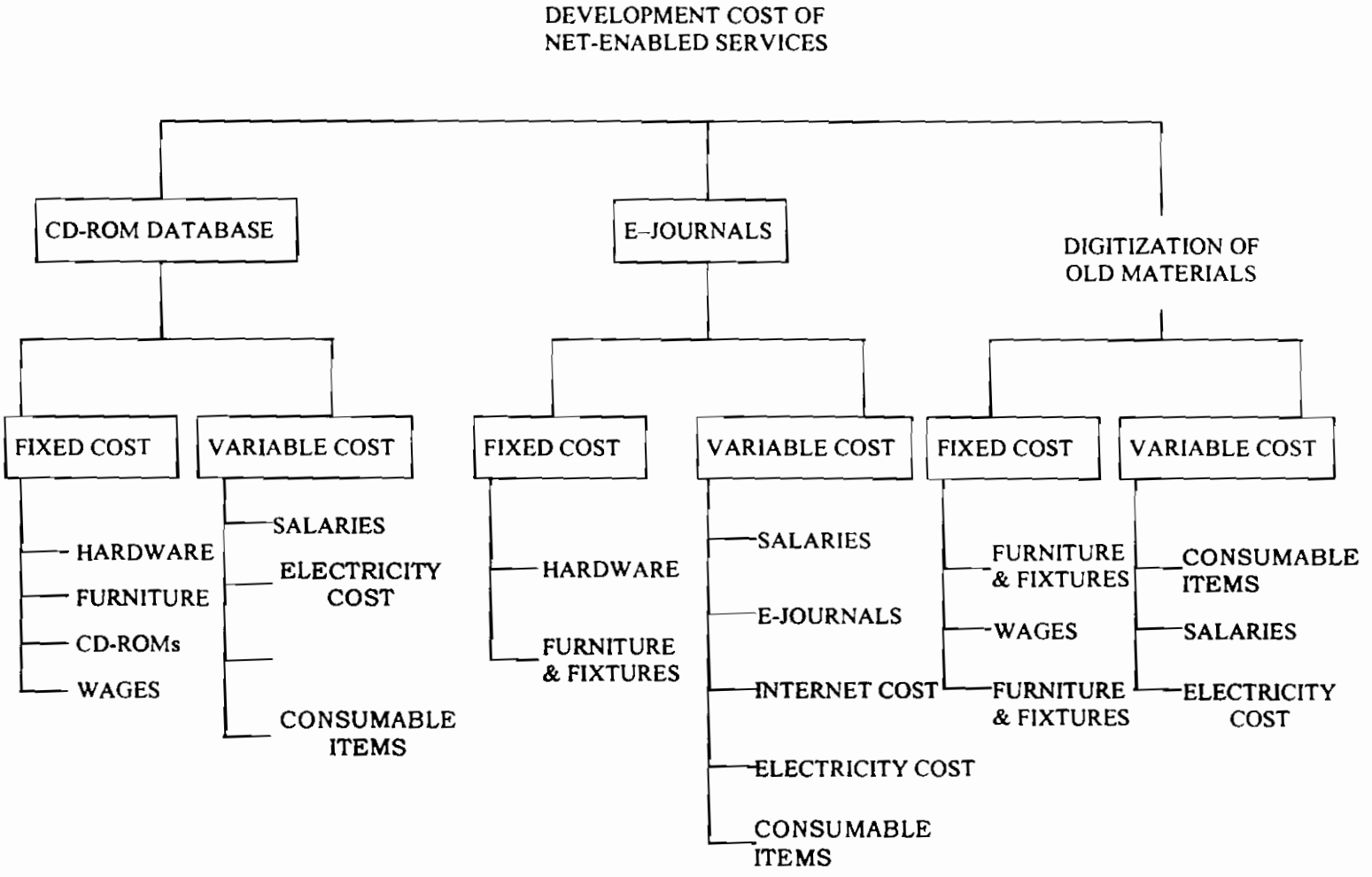


CHART-4


DEVELOPMENT COST OF
NET-ENABLED SERVICES
CD-ROM DATABASE
E–JOURNALS
DIGITIZATION OF
OLD MATERIALS
FIXED COST
VARIABLE COST
FIXED COST
VARIABLE COST
FIXED COST
VARIABLE COST
HARDWARE
FURNITURE
CD-ROMs
WAGES
SALARIES
ELECTRICITY
COST
CONSUMABLE
ITEMS
HARDWARE
FURNITURE
& FIXTURES
SALARIES
E-JOURNALS
INTERNET COST
ELECTRICITY COST
CONSUMABLE
ITEMS
FURNITURE
& FIXTURES
WAGES
FURNITURE
& FIXTURES
CONSUMABLE
ITEMS
SALARIES
ELECTRICITY
COST

Annualized Development Cost of Central Library

This cost has been computed by adding up two costs, namely annualized fixed cost and variable cost. Annualized total fixed cost is sum of the fixed costs of all the division. In the similar fashion, variable cost is summation of all variable costs of all the divisions. Cost function for the present study

$$TC = aFC + VC$$

Where, TC = Total development cost, aFC = annualized fixed cost and VC = Variable cost.

Development Cost of Acquisition (Automation) Division: Development cost of acquisition (automation) division is the sum of the fixed and variable costs. Fixed cost is a cost which has to be incurred before any activity start in acquisition division. Fixed costs involve (a) cost of hardware (computer, printer, networking) (b) Cost of software (c) cost of furniture & fixture. Cost of furniture has been calculated on the basis of expected life as some furniture was old which was used by conventional library but now used in Digital Library. On the other hand, variable cost involves (a) Maintenance cost, (b) Electricity cost which is consumed by computer and allied components, (c) Cost of consumable items, (d) Administrative and technical salaries. Unit cost is also computed for this division. To calculate the unit cost, total development cost of division has been divided by number of users.

Development Cost of Serial (Automation) Division: This cost is also sum of the fixed and variable costs. Fixed and variable costs are two major constituents of total development cost. Fixed costs are sum of (a) cost of hardware, (b) cost of software, (c) cost of furniture & fixture. Variable cost compose by (a) Maintenance cost (b) Electricity (c) Costs of consumable items (d) Administrative and technical salaries paid to the concerned staff of library. Unit user cost has been calculate by dividing total development cost by number of users.

Development Cost of Reader's Service Division: Reader's service division can be divided into two categories

(i) **Circulation System and OPAC** - It is also sum of fixed and variable cost. Cost of computer, software and cost of furniture have been considered as fixed cost. Variable cost takes into account the cost of maintenance and cost of electricity. Here, salaries of the concerned staff come under the head of variable cost.

(ii) **Bar-Coding System** – This system have two kinds of cost i.e. Fixed and variable cost. Fixed cost involves cost of bar-coding printer & scanner, hardware components (computer, networking) software, and wages paid to casual labours (completing bar-coding of 50,000 books & 1100 cards in digital library, IIT Delhi). Later on, it became an ongoing activity in Library. Variable cost includes cost of electricity and expenses incurred on consuming items. The summation of fixed and variable costs constitute development cost. Development cost has been divided by number of users to calculate unit cost.

Finally, we added up both the costs of bar-coding system and OPAC to calculate the total development cost of this division. Further it has been divided by number of user to estimate the per user development cost of reader's service division (unit cost).

Development Cost of Processing (Automation) Division: The formula to calculate the development is almost the same which we have already discussed in each division i.e. for calculating the development cost, we added up all fixed and variable cost. The cost components for fixed and variable costs are also same as discussed earlier.

Development Cost of Net-Based CD-ROM Database: It is the sum of two types of costs namely (a) fixed cost (b) variable cost. The calculations of fixed cost of CD-ROM database(s) takes into account the cost of (i) Equipments – Hardware & Software (ii) Furniture & fixture (iii) wages, and (iv) cost of CD-ROM database(s). The cost of CD-ROM database had been provided in US

dollar, therefore, current transaction rate has been used to convert that cost into Indian currency. The variable cost is sum of (a) Electricity Costs (b) Internet Cost and (c) salaries paid to the technical staff.

Cost of Accessing Electronic Journal: This cost is the summation of various cost incurred on (a) Subscribing electronic journals (b) Electricity cost (c) Internet cost (d) salaries paid to the technical staff, and (e) Cost of consumable items have been considered as variable cost. The annualization formula was also used in the case of fixed costs.

Further, unit cost was also calculated, by dividing total development cost by number of user.

Digitization Cost of fragile journals:

This is summation of two costs namely fixed and variable cost. Fixed costs is sum of (a) Cost of computer, printer, scanner and software, (b) Cost of furniture, and (c) Wages paid to casual labours. Electricity cost and cost of consumable items have considered as the variable cost. These costs have been summed up to find out the development cost. In some sections, maintenance cost includes the maintenance cost of software and do not take into account the maintenance of cost of hardware components because all hardware equipments are still functioning on warranty. However, in future this cost would be added in the total cost.

Above discussion provides methods and formulae used for calculating development cost of each division. Finally, summation of all these costs estimate the total cost or development cost of digital library in IITD. Average cost (unit cost) has also been calculated dividing total cost by number of users. Symbolically,

$AC = TC/N$

Chapter 4

Economic Analysis of Costs

The literature available on cost studies with respect to new educational media has been discussed in previous chapter. However, it did not provide substantial information on the cost structures/components of new information technologies in digital library. In that circumstances, the analysis of cost structures of a digital library alongwith its activities become quite necessary because of its importance in developing a mechanism of resource allocation to the storehouse of knowledge. Therefore, this chapter has tried to analyzes the cost components of new information technology in a digital library and it has emphasized on the analysis of cost in central library of IITD. The costs are examined for all the activities of central library, IITD. The activities of central library have been divided into two main sections (i) automation of In-house operations; and (ii) Net-enabled services. Each section has various activities (acquisition, circulation etc.). The cost structures of all activities are also discussed at length in this chapter.

Cost structures have been analyzed at three levels:

4.1. Annualized development costs of digitization of central library, IITD (2000-2001).

4.2. Percentage shares of Fixed and Variable costs in digitization of central library, IITD (2000-2001).

4.3. Unit User-costs of digitization of Central Library, IITD (2000-2001).

4.1 ANNUALIZED DEVELOPMENT COSTS OF DIGITIZATION OF CENTRAL LIBRARY, IITD (2000-2001)

Table 4.1.1

Total Development Cost of Digitization of Central Library

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	9,29,116.16 (37.70)	1.	Maintenance	50,000.00 (0.65)
2.	Software	65,100.00 (2.64)	2.	Consumable items	126,400.00 (1.64)
3.	Furniture and Fixtures	35,170.00 (1.42)	3.	Electronic Journals	13,25,381.00 (17.28)
4.	CD-ROM Database	12,75,884.00 (51.78)	4.	Salaries	
5.	Wages	158,600.00 (6.43)		a) Administrative	6,66,000.00 (8.68)
				b) Technical	19,98,000.00 (26.06)
			5.	Internet	32,00,000.00 (41.74)
			6.	Electricity	3,00,000.00 (3.91)
	Total	**24,63,870.16 (100)**		**Total**	**76,65,781.00 (100)**

Note: Figures in parenthesis denote percentages.

Table 4.1.1 depicts the fixed and variable cost components of annualized total development cost. In fixed cost components, hardware cost is Rs. 9,29,116.16 (37.70 percent of the annualized fixed cost). The software constitute 2.64 percent of total annualized fixed cost whereas CD-ROM database(s) cost is highest cost in this category. It constitutes 51.78 percent of annualized fixed cost because its takes into account annualized cost of all CD-ROM database(s) which have been purchased over the years. However, labour charge i.e. wages of casual labour form 6.43 percent of total annualized fixed cost. In variable cost components, Internet cost has come out to be the highest cost (41.74 percent of the total variable cost), because total Internet cost has

been taken into consideration while calculating the cost of Internet in central library. Internet cost could be lower for small digital library or other organizational library. In the context of Indian Institute of Technology, Delhi (IITD) a special lease line (2mbp) has been fixed so that entire institution could get smooth flow of information and this facility could be used by each department according to their needs, (Internet facility has been provided in the entire institution free of cost so that researchers and students could access the Internet based information and library facility through Intranet without even entering the premises of central library).

Salaries component has been divided into two categories (i) Administrative Salaries - which constitute 8.68 percent and (ii) Technical Salaries which works out to be 26.06 percent of total variable cost. If, all the variable components are summed up, it constitutes the total variable cost in central library, computed to be Rs. 76,65,781. And annualized development cost is Rs. 101,29,651.16.

Table 4.1.2

Total Development Cost of Automation of In-house Operations

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	2,85,759.23 (72.60)	1.	Maintenance Cost	50,000.00 (2.05)
2.	Software	65,100.00 (16.54)	2.	Consumable Items	88,000.00 (3.62)
3.	Furniture and Fixtures	9,120.00 (2.31)	3.	Salary	
4.	Wages	33,600.00 (8.53)		a) Administrative	6,66,000.00 (27.40)
				b) Technical	16,26,000.00 (66.91)
	Total	**3,93,579.23 (100)**			**24,30,000.00 (100)**

Note: Figures in parenthesis denote percentages.

Table 4.1.2 shows the development cost of automation of in-house operations in central library, IITD. This table depicts the different cost components that have been used to calculate the development cost of this division.

The annualized fixed cost is Rs. 3,93,579.23. This cost is lower than variable cost because all technological advanced equipments have been calculated by taking risk factor into consideration at the 6 percent rate of interest. The variable cost is Rs. 24,30,000. Other variable costs such as Internet and electricity cost have been discussed in Table 4.1.1 and summed up in annualized total development cost of central library. The annualized total development cost of this division is Rs. 28,23,579.23 which is summation of total annualized fixed cost (Rs. 393,579.23) and total variable cost (Rs. 24,30,000).

Table 4.1.3

Total Development Cost of Net-Enabled Services

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	6,43,356.93 (31.07)	1.	Electronic Journals	13,25,381.00 (76.35)
2.	Furniture and fixture	26,050.00 (1.25)	2.	Consumable Items	38,400.00 (2.21)
3.	CD-ROM Database	12,75,884.50 (61.62)	3.	Salary (Technical)	3,72,000.00 (21.43)
4.	Wages	1,25,000.00 (6.03)			
	Total	**20,70,291.43 (100)**		**Total**	**17,35,781.00 (100)**

Note: Figures in parenthesis denote percentages.

Table 4.1.3 reveals the development cost of net-enabled services, where vast digital information has been made available to users. Cost of accessing CD-ROM database, electronic journal and digitization of old journals had been

included for this purpose. This table is sum of disparities in Table 4.1.9, 4.1.10 and 4.1.11 where expenditure incurred on these facilities have been analyzed.

This table is summation of two costs. The annualized fixed cost includes the cost of hardware components, furniture and fixture, CD-ROM database and salaries paid to the staff for the development of these facilities. Further, hardware cost has been divided into different subheads, like computers, services, printers etc. The total annualized fixed cost of this division works out to be Rs. 20,70,291.43. In similar way, variable cost has been defined. That cost like annualized fixed cost is the summation of costs, like, e-journals, consumable items, salaries. However, cost of electronic journal has come out to the highest cost in this section. The sum of variable costs has come out to be Rs. 17,35,781. The annualized total development cost of this division is Rs. 38,06,072.43 which is the summation total fixed (Rs. 20,70291.43) and variable (17,35,781) costs.

Table 4.1.4

Development Cost of Acquisition Division (Automation)

(2000-2001)

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	24,149.00 (57.77)	1.	Maintenance Cost	12,500.00 (3.32)
2.	Software	16,250.00 (38.83)	2.	Consumable Items	10,000.00 (2.65)
3.	Furniture and Fixtures	1,440.00 (3.40)	3.	Salary	
				a) Administrative	1,50,000.00 (39.84)
				b) Technical	2,04,000.00 (54.18)
	Total	**41,839.00 (100)**		**Total**	**3,76,500.00 (100)**

Note: Figures in parenthesis denote percentages.

In Digital Library, development cost can be divided into two categories i.e. annualized fixed cost and variable cost. Fixed cost is the sum of the different costs incurred on hardware devices, software, furniture and fixtures.

Fixed cost has been calculated by annualizing the costs of all equipments taking risk factor into consideration calculated at 6 per cent rate of interest.

Table 4.1.4 reveals that in the acquisition division, annualized fixed cost is lower than variable cost. Fixed cost is calculated to be Rs. 41,839, while variable cost is calculated to be Rs. 3,76,500. In annualized fixed cost, hardware constitutes the cost of computers, printer and networking of computers in this division. Acquisition division acquired one Pentium computer, at an annualized cost of Rs. 7584. The annualized cost of two terminal computers (which are connected to other computers through networking) is calculated to be Rs. 7110 and the cost of dot-matrix and laser printer is Rs. 380 and Rs. 6840, respectively. The cost of networking is calculated to be Rs. 2235. The total hardware cost comes out to be Rs. 24,149 constituting 57.77 per cent of the total annualized fixed cost.

Annualized cost of software is calculated to be Rs. 16,250. This software cost is estimated for four divisions, as it would be used in all four divisions simultaneously. Therefore, total annualized cost has been divided by the number of divisions. The cost of furniture and fixture is estimated to be Rs. 1,440.

Variable cost has been divided into three categories: (i) maintenance cost of software, (ii) cost incurred on consumable items and (iii) salaries paid to the staff. Maintenance cost of software is Rs. 12,500. The software (LIBSYS) requires maintenance on regular basis to update with new technologies. This maintenance cost does not include the computer maintenance cost as all hardware devices are on warranty. Salaries of the staff members could be divided into two groups: (i) Administrative salaries paid to the staff who are involved in administrative jobs (decision making bodies). This amount is estimated to be Rs. 1,50,000 comprising 39.84 percent of the variable cost. (ii) Salaries paid to the staff involved in technical operations like operating the system and processing of digitization, which comes out to be Rs. 2,04,000. If

we sum up the salaries of personnel in both the categories, it constitutes 94 percent of the total variable cost, which is Rs. 3,76,500.

Table 4.1.5

Development Cost of Serial Division (Automation)

(2000-2001)

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	1,03,191.00 (84.36)	1.	Maintenance Cost	12,500.00 (1.95)
2.	Software	16,250.00 (13.28)	2.	Consumable Items	18,000.00 (2.80)
3.	Furniture and Fixtures	2,880.00 (2.35)	3.	Salary	
				a) Administrative	3,00000.00 (46.69)
				b) Technical	3,12,000.00 (48.56)
	Total	**1,22,321.00 (100)**		**Total**	**6,42,500.00 (100)**

Note: Figures in parenthesis denote percentages.

In table 4.1.5, development cost of serial division has been divided into two categories: (i) fixed cost, and (ii) variable cost. Fixed cost consists of (i) the cost of hardware devices (ii) the cost of software, and (iii) the cost of furniture and fixtures. The cost of hardware devices includes the cost of four Pentium computer, two terminal computers, two printers, three UPS systems and cost of networking. The cost of computers is estimated to be Rs. 30,336. The cost of terminals is estimated to be Rs. 7,110, whereas, cost of printer and UPS is 13,680 and 47,595 respectively. The cost of networking is 4,470. Consequently, cost of hardware which works out to be Rs. 1,03,191.

The cost of software (LIBSYS) works out to be Rs. 16,250.00. The Libsys software is used in other divisions (the total cost of which is Rs. 5,00,000). The cost of furniture and fixtures is estimated to be Rs. 2,880. The cost of furniture has been calculated on the basis of their projected life as some of the furniture items were old, even, to be used in conventional library. Hence, the annualized fixed cost of division works out to be Rs. 1,22,321.

The total variable cost is very high as compared to annualized fixed cost. The variable costs have been divided into three categories (i) maintenance cost of software, (ii) salaries of staff and (iii) cost incurred on consumable items, e.g. the cost of paper, cartridge, ribbon, floppy and floppy boxes.

The maintenance cost of (LIBSYS's software) works out to be Rs. 12,500. This software requires maintenance on a regular basis to be updated with new technologies. Maintenance cost of other hardware devices could not be included since all devices were on warranty. Therefore, their maintenance cost is borne out by the company for the warranty period. If, these costs were to be borne by serial division itself, then variable cost could have been relatively higher than the present estimates. Salaries of staff have been divided into two groups: (i) Salaries paid to the administrative staff involved in the administrative services, the amount of which is estimated as R. 3,00,000; (ii) Salaries paid to the technical staff who are involved in the digitization process. The amount of salaries to the technical staff is estimated to be Rs. 3,12,000. If we add the amount of salaries paid to the staff, both administrative and technical, it comes out to be Rs. 6,12,000. The cost incurred on consumable items turns out to be Rs. 18,000. The total variable cost of serial services (automation) works out to be Rs. 6,42,500.

The annualized total development cost of serial division is estimated to be Rs. 7,64,821. Mere annualized fixed cost is very low as compared to variable cost, reasons being, first, variable cost is inclusive of the salaries of administrative and technical staff and secondly, annualized fixed cost is an annualized cost as mentioned earlier. Life span and risk factors have been taken into consideration while calculating the annual cost of any hardware equipment.

Table 4.1.6

Development Cost of Processing Division (Automation)

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	66,572.82 (79.0)	1.	Maintenance Cost	12,500.00 (3.0)
2.	Software	16,250.00 (19.28)	2.	Consumable Items	12,000.00 (2.89)
3.	Furniture and Fixtures	1,440.00 (1.70)	3.	Salary (Technical)	3,90,000.00 (94.0)
	Total	**84,6262.82 (100)**		**Total**	**4,14,500.00 (100)**

Note: Figures in parenthesis denote percentages.

Though processing of documents is not a center-stage activity, yet it is definitely one of the most important functions in library that contribute to proper storage and retrieval of information in a library. In table 4.1.6, cost of processing services has also been divided into annualized fixed cost and variable cost.

The annualized fixed cost involves the cost of hardware components, software and furniture and fixtures. Hence, annualized fixed cost is the summation of these three different costs. The cost of hardware components is Rs. 66,572.82. This cost again is the summation of several other costs, including annual cost of two computers (Rs. 15,372.82), Terminal cost (Rs. 3555), cost of two printer computers (Rs. 13680), cost of UPS (Rs. 31,730), and cost of networking in this division Rs. 2235. The cost of software has been included in annualized fixed cost. The attributed cost of software is Rs. 16,250. The costs of furniture and fixture are estimated to be Rs. 1,440; The cost of furniture cost involves the cost incurred on chairs, tables and other special furnitures that have been bought for automation service.

The second cost component of processing service is variable cost which includes maintenance cost, cost incurred on consumable items and salaries of the staff. Here, only maintenance cost of software has been taken into account. This cost is Rs. 12,500. The expenditure incurred on consumable items; which

is also known, as consumable cost is Rs. 12,000. The salaries of technical staff is estimated to be Rs. 3,90,000. Thus, the total variable cost would come out to be Rs. 4,14,500. As mentioned in the methodology, this cost estimate may be low due to unavailability of breakup of some cost information. Therefore total variable cost of Central Library in table no. 4.1.1 would incorporate the all variable cost. The annualized total development cost of processing division comes out to be Rs. 4,98,762. In these cost estimates the variable cost is higher due to the salary factor as salaries are determined by government policies and not by the market forces.

Table 4.1.7

Development Cost of Circulation Division (Automation) and OPAC

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	38,531.41 (66.82)	1.	Maintenance Cost	12,500.00 (1.46)
2.	Software	16,250.00 (28.18)	2.	Consumable Items	12,000.00 (1.40)
3.	Furniture and Fixtures	2,880.00 (4.99)	3.	Salary	
				a) Administrative	2,16,000.00 (25.33)
				b) Technical	6,12,000.00 (71.78)
	Total	**57,661.41 (100)**		**Total**	**8,52,500.00 (100)**

Note: Figures in parenthesis denote percentages.

The Reader's Service Division takes the responsibility of user-related activities. This division has several important activities that have been computerized, e.g. the circulation counter has acquired computer for easy and efficient service and OPAC (Online Public Access Catalogue) facility is also introduced to make it more user-friendly. Therefore, this table reveals the development cost of both circulation system and OPAC because both the services are dependent on each other.

All costs have been divided into fixed and variable costs. The annualized fixed cost comprises the cost of hardware, software and furniture and fixture. The hardware cost is inclusive of several other costs viz. cost of

computer is Rs. 7686.41 and eight terminals have been used for OPAC service; there the estimated cost is Rs. 17,775. Further, five dot matrix printers have also been incorporated the cost of which is Rs.1900 and the remaining cost is the cost of networking and its components. Therefore, cost of hardware components is Rs. 38,531. The 'LIBSYS' software has been used for all activities, therefore, it become necessary to have a mention of software cost which is Rs. 16,250.00 Besides this, cost of furniture and fixture also related to annualized fixed cost which is Rs. 2,880. Finally, the variable cost of division which is recurring in nature, includes the cost incurred on consumable items, cost of software's maintenance and staff's salaries. The total annualized fixed cost is Rs. 57,661.41.

The maintenance cost is Rs. 12,500, whereas expenditure incurred on consumable items is Rs. 12,000. Salaries are divided into two categories: (i) salaries paid to the administrative staff (head of the division). This amount is 216,000 (ii) salaries paid to the technical staff and this amounts is Rs. 612,000. The summation of both salaries constitutes the 97 percent of the variable cost. So, total variable cost comes out to be Rs. 8,52,500. Summing up the total fixed and total variable cost, annualized total development cost of this division works out to be Rs. 9,10,161.41.

Table 4.1.8
Development Cost of Bar-Coding System

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	53,315.00 (60.93)	1.	Consumable Items	36,000.00 (25.0)
2.	Software	100.00 (0.11)	2.	Salary (Technical)	1,08,000.00 (75.0)
3.	Furniture and Fixtures	480.00 (0.54)			
4.	Wages	33,600.00 (38.40)			
	Total	**87,495.00 (100)**		**Total**	**1,44,000.00 (100)**

Note: Figures in parenthesis denote percentages.

Bar-coding system comes under the banner of Reader's Services Division. In the library of IITD, about 500 bar-coded cards of library have been made. Besides, the library is in the process of getting the books issued with the help of bar-coded cord and bar-coded books have also been introduced. Therefore, it is necessary to understand the cost components of this system as well. For this reason, cost components have been clubbed into two categories: fixed cost and variable cost.

Table 4.1.8 shows the cost structure of this division. Here, annualized fixed cost includes the cost of hardware, software, furniture and fixtures and salaries paid to casual labour. Therefore, hardware cost constitutes one of the major cost figures. It involve the cost of computers which is Rs. 13,200 (annualized cost), whereas, the cost of printer and scanner' is Rs. 24,150. Finally, cost of UPS is Rs.15,865. Therefore, all these costs form the hardware cost which is Rs. 53,215. The cost of software is Rs. 100 only which is required for bar-coding purpose. Another component of annualized fixed cost is cost of furniture that is Rs. 480 only, while the wages of casual labour are one of the major constituents of the annualized fixed cost, which is estimated to be Rs. 33,600. The sum of all cost components of annualized fixed cost works out to be Rs. 87,495.

The variable cost is another cost which has also been taken into consideration. The cost of stationary and its allied components constitute the variable cost for this division. This cost is calculated to be Rs. 36,000. Salary of the regular staff is Rs. 1,08,000. Therefore, Total Variable Cost would add up to Rs. 144,000.

The summation of both fixed and variable costs constitute the annualized total development cost. The annualized total development cost is Rs. 231,495.00.

Table 4.1.9
Development Cost of Net-Based CD-ROM Database(s)

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	2,97,706.22 (18.49)	1.	Consumable Items	12,000.00 (11.11)
2.	Furniture and Fixtures	12,025.00 (0.74)	2.	Salary (Technical)	96,000.00 (89.89)
3.	CD-ROM database	12,75,884.00 (79.21)			
4.	Wages	25,000.00 (1.55)			
	Total	**16,10,615.22 (100)**		**Total**	**1,08,000.00 (100)**

Note: Figures in parenthesis denote percentages.

Central library of IITD has made a major breakthrough in the process of digitization as they have incorporated the CD-ROM database to get faster and vast amount of information. CD-ROM saves money, space and time, and it is very easy to handle as well as store vast amount of information within limited space. Before opting for this idea, it would be necessary to understand the cost structure of this service.

Cost structures can be studied by dividing into two components i.e. fixed cost and variable cost. Fixed cost comes out to be Rs. 16,10,615.22 for this service. This cost has been computed by summing up the cost of hardware components, cost of CD-ROM databases(s), cost of furniture and fixtures and wages paid to casual labour. The hardware cost comprises the cost of computer, server, printer, UPS, CD-ROM, Net and networking. The cost of computer comes out to be Rs. 1,71,986.22 and the cost of server is 46,800. The cost of printer is Rs. 20,520. The cost of UPS is Rs. 31,730, a cost of CD-ROM Net is Rs. 16,240 and the cost of networking of computers cost is Rs. 10,430. Summation of all these costs provide the hardware cost which is Rs. 2,97,706.22. The cost incurred on CD-ROM database(s) is estimated to be Rs. 12,75,884.50. This cost is substantially higher as a large number of database(s) have been purchased to build a rich collection of information over the years.

Several modifications had to be made in the previous set up this section of library in order to start this service. New furnitures and fixture have been purchased. The cost of which comes out to be Rs. 12,025.80. The wages paid to casual labour are estimated to be Rs. 25,000. All these costs components constitute the annualized fixed cost which has been given earlier.

The variable cost which includes cost of consumable items and salaries of technical staff, has come out to be low in comparison to annualized fixed cost. The consumable item cost is Rs. 12,000 and the amount of salaries is Rs. 96,000. However, the cost incurred on Internet and electricity are other important variable cost components. These costs could not be included in this section as breakup of this cost information was not available. Hence, these variable costs have been summed up in the table 4.1.1 which shows the development cost of digital library of IITD.

Table 4.1.10
Development Cost of Accessing Electronic Journals

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	2,65,246.00 (95.66)	1.	Electronic Journals	13,25,381.00 (82.14)
2.	Furniture and Fixtures	12,025.00 (4.34)	2.	Consumable Items	12,000.00 (0.74)
			3.	Salary (Technical)	2,76,000.00 (17.10)
	Total	**2,77,271.00 (100)**		**Total**	**16,13,381.00 (100)**

Note: Figures in parenthesis denote percentages.

Digital library has been divided into several divisions. Each division contains different type of cost component. However, these cost components have been clubbed under two head namely, fixed and variable cost.

In Table 4.1.10, annualized fixed cost is the summation of (i) expenses incurred on hardware component; and (ii) expenses incurred on furniture and fixtures. Hardware components include computer, server, UPS and networking system. Here, cost of computers is estimated to be Rs. 1,71,986. This cost

seems to be high as large number of computers have been employed for providing this facility. Only one server is being used to download the material which cost comes out to be Rs. 46,800. The UPS system cost comes out to be around Rs. 31,730. In this division, one terminal computer is also used to access the information from the web. The terminal cost is Rs. 3555 and remaining cost can be attributed to the networking and its components. The total cost of hardware components comes to be Rs. 2,65,246. The cost of furniture and fixtures is estimated to be Rs. 12,025. The expenses incurred on annualized fixed cost of this division are estimated to be Rs. 277,271.

Variable costs include the expenditures incurred on (i) subscription of electronic journals; and (ii) salaries paid to the technical personnel involved in the activity of this division. Major cost under this head is subscription of e-journals, which cost comes out to be Rs. 13,25,381. Expenditures on miscellaneous items are computed to be Rs. 13000. Salaries of technical staff are Rs. 2,76,000. The sum of these three component of variable costs is added up to Rs. 16,13,381. The annualized total development cost of this division works out to be Rs. 18,90,652.

Table 4.1.11

Development Cost of Digitization of Old Journals

2000-2001

S.N.	Annualized Fixed Cost		S.N.	Variable Cost	
	Components	**Amount (Rs.)**		**Components**	**Amount (Rs.)**
1.	Hardware	80,404.71 (44.04)	1.	Consumable Items	14,400.00 (100)
2.	Furniture and Fixtures	2,000.00 (1.08)			
3.	Wages	1,00,000.00 (54.0)			
	Total	**1,82,404.71 (100)**		**Total**	**14,400.00 (100)**

Note: Figures in parenthesis denote percentages.

Digitization of old journals in central library of IITD was a tedious task. Some technologically advanced equipments had to purchased, and long-term investments were made for this activity. The entire expenditure has been divided into two categories, namely fixed cost and variable cost.

Here again, annualized fixed cost is derived by summing up three cost components. These are (i) cost of hardware components (ii) cost of furniture and fixture (iii) salaries paid to the concerned staff. Cost of hardware component is derived at Rs. 80,404.71. This cost has been derived by adding the cost of one computer which is Rs. 12,284.71, cost of one server which is Rs. 46,800. The cost of scanner which is Rs. 13,160 and the cost of hard disc and software which is Rs. 8160. The cost of furniture and fixture is nominal which is Rs. 2050 only. A technical personnel is to be appointed for this task. The salary of personnel is estimated to be Rs. 1,00,000. Total annualized fixed cost of this division comes out to be Rs. 1,82,404.71.

Variable cost in this division includes only one cost component that is cost incurred on consumable items, such as stationary, ink, ribbon, etc. The variable cost is Rs. 14,400 only. The variable cost is low as some variable cost e.g. the cost of Internet and electricity could not be taken into account in this Table. However, expenditure on these sub heads has been added in final Table 4.1.1. Besides this, maintenance cost of hardware is also a part of variable cost, but it could not taken into account for because all equipments are still on warranty. However, after the completion of warranty period this cost would have be added into variable cost. Total development cost consumed in the digitization of old journals is estimated to be Rs. 196804.71.

4.2 PERCENTAGE SHARE OF FIXED AND VARIABLE COSTS IN DIGITIZATION OF CENTRAL LIBRARY, IITD (2000-2001).

Table 4.2.1

Percentage Share of Fixed and Variable Costs of Digitization in Central Library 2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	9.17
	(ii)	Software	0.64
	(iii)	Furniture and Fixtures	0.34
	(iv)	CD-ROM Database	12.59
	(v)	Wages	1.56
2.	**Variable Cost Components**		
	(i)	Maintenance Cost (Software)	0.49
	(ii)	Consumable Items	1.24
	(iii)	Electronic Journals	13.08
	(iv)	Internet	31.59
	(v)	Electricity	2.96
	(vi)	Salaries	
		a) Administrative	6.57
		b) Technical	19.72
Percentage (Amount in Rs.)			**100 (101,29,651.16)**

The Table 4.2.1 depicts the percentage share of fixed and variable costs in central library, IITD. In fixed cost components, hardware device constitute 9.17 percent while software is 0.64 percent. In digitization process furniture cost is lowest cost at 0.34 percent. CD-ROM database(s) cost is a major composition of total cost. It constitutes 12.59 percent of total cost. Labour cost (i.e. wages of casual labour) form 1.56 percent. This amount had been spent to develop the digitized journals and networking of CD-ROM database facilities. In variable cost components, two cost i.e. maintenance of software and consumable items constitute very nominal share, which is 0.49 and 1.24 percent respectively. The cost of electronic journals which is an important cost

in digital library, constitutes 13.08 percent of total cost, while Internet cost is highest cost which composes 31.59 percent of annualized total development cost. The Internet cost is relatively high in IITD. However, this cost could be lower in the case of small digital library as lower amount of Internet access could be required. Further, the breakup of Internet cost between Internet used for library facilities and other activities was not available. This also raised the share of Internet cost in total development to some extent. Electricity cost constitutes 2.96 percent while salary components 26.29 percent, out of this salaries of administrative staff form 6.57 percent and salaries of technical staff is 19.72 percent. However, salaries of technical staff do not include the salaries of technical personnel who were employed to develop this facility in library. As all technical support had been supplied by computer department of IITD itself. This salary component includes the salaries of the technical staffs that are operating the system and doing little technical work.

Table 4.2.2

Percentage Share of Fixed and Variable Costs in Automation of In-house Operations

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	10.12
	(ii)	Software	2.30
	(iii)	Furniture and Fixture	0.32
	(iv)	Wages	1.18
2.	**Variable Cost Components**		
	(i)	Maintenance Cost	1.77
	(ii)	Consumable Items	3.11
	(iii)	Salary	
		a) Administrative	23.58
		b) Technical	57.58
Percentage (Amount in Rs.)			**100 (28,23,579.23)**

Table 4.2.2 shows the percentage expenditure of fixed and variable costs in development cost of automation of in-house operations (acquisition, serial circulation, etc.). As this Table shows, hardware components constitute 10.12 percent while software is 2.30 percent of total cost. Once again, furniture and fixture cost is very nominal in comparison to other components, i.e. 0.32 percent, whereas, maintenance of software (LIBSYS) and consumable items cost is around 1.77 percent and 3.11 percent respectively. In this section, salary component has been categorized into two groups (salaries of administrative and technical staff). Salaries of Administrative staff forms 23.58 percent while salaries of technical staff is 57.58 percent of annualized total development cost of this division. This clearly indicates that salaries constitute a major component of total cost.

Table 4.2.3

Percentage Share of Fixed and Variable Costs of Net-enabled Services

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	16.90
	(ii)	Furniture and Fixtures	0.68
	(iii)	CD-ROM Database(s)	33.52
	(iv)	Wages	3.28
2.	**Variable Cost Components**		
	(i)	Miscellaneous	1.00
	(ii)	Subscription of Electronic Journals	34.82
	(iii)	Salary (Techincal)	9.77
Percentage (Amount in Rs.)			**100 (38,06,072.43)**

As Table 4.2.3 shows, hardware component constitute 16.90 percent of total cost. This cost is higher than the cost of hardware components of in-house operations (Table 4.2.2), as net-enabled services require more sophisticated and

advanced equipments (computer, printer, scanner, etc.). Furniture cost is nominal at 0.68 percent of total cost in this division. CD-ROM database (expenditure) is one of the major cost of this section. It constitutes 33.52 percent of total cost. To develop this facility, 3.28 percent of total cost has been spent on casual labour. Subscription of electronic journals constitute 34.82 percent, whereas salaries of technical staff form only 9.77 percent. If one looks at the table, one may safely say that hardware component and CD-ROM database(s) are major constituents of the annualized fixed cost, and cost of electronic journal subscription is variable cost, which forms the major composition of total cost.

Table 4.2.4

Percentage Share of Fixed and Variable Costs in Acquisition Division (Automation)

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	5.77
	(ii)	Software	3.88
	(iii)	Furniture and Fixture	0.35
2.	**Variable Cost Components**		
	(i)	Maintenance Cost	2.99
	(ii)	Consumable Items	2.39
	(iii)	Salary	
		a) Administrative	35.85
		b) Technical	48.76
Percentage (Amount in Rs.)			**100 (418339.00)**

Table 4.2.4 depicts percentage share of fixed and variable cost in development cost of acquisition service (automation). In acquisition division, hardware components constitute 5.77 percent while software 3.88 percent of development cost. As seen in the above Table, furniture cost is nominal at 0.35 percent. The salary components are divided into two categories – salaries paid

to the Administrative personnel and salaries paid to the technical staff. Salaries of administrative personnel constitute 35.85 percent, whereas salaries of technical staff is 48.76 percent of the total cost. The Table clearly indicates that salaries components constitute a major part (around 86 percent of development cost of acquisition division). This, however, implies that IITD follows the salary structure set by the central government of India. As a consequences of this the staff involved in the digitization of central library is not paid on the basis of productivity and skills; rather they are paid on a more regularized wage policies of the government.

Table 4.2.5

Percentage Share of Fixed and Variable Costs of Serial Division (Automation)

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	13.42
	(ii)	Software	2.12
	(iii)	Furniture and Fixture	0.37
2.	**Variable Cost Components**		
	(i)	Maintenance Cost	1.63
	(ii)	Consumable Items	2.35
	(iii)	Salary	
		a) Administrative	39.22
		b) Technical	40.79
Percentage (Amount in Rs.)			**100 (764,821.00)**

The Table 4.2.5 reveals the fixed and variable costs as percentage of development cost of this division. Among the annualized fixed cost components, Hardware devices constitute 13.42 percent whereas, software cost is 2.12 percent of the total cost. As the Table reveals, furniture and fixture cost is nominal at 0.37 percent. Among the variable cost components, maintenance

cost constitutes 1.63 percent, and software and consumable items constitute 1.63 percent and 2.35 percent respectively.

Salary component has been categorized under variable cost components. Salary component has been divided into two groups according to nature of the work. Salaries paid to the administrative personnels form 39.22 percent, at the same time, salaries paid to the technical staff also constitutes a major share at 40.79 percent.

Table 4.2.6

Percentage Share of Fixed and Variable Costs of Processing Service (Automation)

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	13.34
	(ii)	Software	3.25
	(iii)	Furniture and Fixture	0.28
2.	**Variable Cost Components**		
	(i)	Maintenance Cost	2.50
	(ii)	Consumable Items	2.40
	(iii)	Salary (Technical)	78.19
Percentage (Amount in Rs.)			**100 (4,98,762.82)**

Table 4.2.6 shows that the cost of hardware devices, which is fairly high at 13.34 percent of the total cost while software constitutes 3.25 percent. If we look at the furniture and fixture's share, we find that furniture and fixture cost constitutes a nominal share at 0.28 percent. Salary is the major component of total cost as seen in above table, which constitutes only technical salaries. Technical salaries form 78.19 percent of total cost. However, no administrative salaries have been taken into account as all members of the staff were involved in technical jobs only.

Table 4.2.7

Percentage Share of Fixed and Variable Costs of Circulation Services (Automation) and OPAC

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	4.23
	(ii)	Software	1.78
	(iii)	Furniture and Fixture	0.31
2.	**Variable Cost Components**		
	(i)	Maintenance Cost	1.37
	(ii)	Consumable Items	1.31
	(iii)	Salary	
		a) Administrative	23.74
		b) Technical	67.27
Percentage (Amount in Rs.)			**100 (9,10,161.41)**

Table 4.2.7 shows the percentage share of fixed and variable costs in automation of circulation services and OPAC facility. In circulation services, hardware cost constitute 4.23 percent while software cost constitute 1.78 percent of the total cost. On the other hand, cost of maintenance and consumable items have come out to be 1.37 percent and 1.31 percent respectively. If we look at the salary composition, we will find that salaries paid to the technical staff constitute a high 67.27 percent as compare to salaries of administrative staff at 23.74 percent.

Table 4.2.8

Percentage Share of Fixed and Variable Costs of Bar-coding System

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	23.0
	(ii)	Software	0.043
	(iii)	Furniture and Fixture	0.20
	(iv)	Wages	14.51
2.	**Variable Cost Components**		
	(i)	Consumable items	15.55
	(ii)	Salary (Technical)	46.65
Percentage (Amount in Rs.)			**100 (2,31,495.00)**

Table 4.2.8 depicts the percentage share of fixed and variable costs in development cost of bar-coding system. In bar-coding system of the reader's service, hardware components constitute 23.0 percent of development cost while the cost of software is very low at 0.043 percent. As seen in the Table, furniture cost is very nominal at 0.20 percent. Moreover, share of labour charge (the cost incurred on casual labour) constitutes 14.51 percent of total cost. Among the variable cost components "Consumable items" form one of the major components of development cost (15.55 percent). Salaries are another major cost which constitute 46.65 percent of total cost.

Table 4.2.9
Percentage Share of Fixed and Variable Costs of Net-based CD-ROM Database

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	17.32
	(ii)	Furniture and Fixture	0.69
	(iii)	CD-ROM Database	74.23
	(iv)	Wages	1.45
2.	**Variable Cost Components**		
	(i)	Consumable Items	0.69
	(ii)	Salary (Technical)	5.58
Percentage (Amount in Rs.)			**100 (1718615.22)**

Table 4.2.9 shows the percentage share of fixed and variable costs of development cost of net-based CD-ROM databases. To develop net-based CD-ROM database(s), the cost of hardware components has come to be 17.32 percent of the total cost. The cost of furniture and fixture forms 0.69 percent. The cost of CD-ROM database(s) is important component of the total cost. It constitutes 74.23 percent of the total cost, whereas, wages paid to casual labour to develop this system is 1.45 percent. There are some other miscellaneous costs involved in the digitization process, which have come out to be 0.69 percent of total cost. Salaries of technical staff constitute 5.58 percent of the total cost.

Table 4.2.10

Percentage Share of Fixed and Variable Costs for Accessing Electronic Journal

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware	14.0
	(ii)	Furniture and Fixtures	0.63
2.	**Variable Cost Components**		
	(i)	Subscription of electronic journals	70.10
	(ii)	Consumable Items	0.63
	(iii)	Salary (Technical)	14.59
	Percentage (Amount in Rs.)		**100 (18,90,652.00)**

Table 4.2.10 reveals the percentage expenditure on fixed costs and variable costs of development cost to facilitate the access of electronic journal's in central library. Hardware components constitute 14.0 percent of the total cost. Subscription of electronic journal is major component of total cost, which constitutes around 70.00 percent (various pricing models have been formed for electronic journals. Some of them are described in appendix G). Salary components are another major components of total cost, which share 14.59 percent.

Table 4.2.11

Percentage Share of Fixed and Variable Costs of Digitization of Old Journals

2000-2001

S.N.	Types of Cost		Percentage of Expenditure
1.	**Fixed Cost Components**		
	(i)	Hardware Devices	40.85
	(ii)	Furniture and Fixtures	1.01
	(iii)	Labour Charge	50.80
2.	**Variable Cost Components**		
	(i)	Consumable Items	7.31
	Percentage (Amount in Rs.)		**(100) (196,804.71)**

If one looks at Table 4.2.11, it reveals that hardware components constitute 40.86 percent of total cost, while the cost of furniture and fixture is very low at 1.02 percent. On the other hand, wages of casual labour to develop this facility constitute 50.80 percent of total cost. However, consumable items do not form major share and constitute only 7.81 percent of total cost.

4.3 UNIT COST OF DIGITIZATION OF CENTRAL LIBRARY, IITD (2000-2001).

Table 4.3.1

Unit Cost of Digitization of Central Library

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	615.96
2.	Variable Cost	1916.44
	Total	**2532.40**

Table 4.3.1 reveals the total unit cost of digitization of central library. If we look into the figures, we find that fixed unit cost is lower than variable unit cost (fixed unit cost is Rs. 615.96, while variable unit cost is Rs. 1916.44). Variable unit cost is very high because expenses incurred on Internet, E-journal and salaries paid to the staff of library constitute major components. Amounts incurred on these components are comparatively higher than those on other components. Tables in this section reveal that software and furniture cost is very nominal in comparison to other cost components (Table 4.3.1 is summation of table 4.3.2 and 4.3.3). However, in Net-enabled services, fixed unit cost is more or less similar to variable unit cost whereas fixed unit cost of automation of In-house operations section has come out to be lower than variable unit cost. Because salaries paid to the staff form the major component of variable cost of In-house operations, variable unit cost works out to be higher than fixed unit cost (Variable unit cost of automation of in-house operations is Rs. 607.48 and fixed unit cost is Rs. 98.37). Finally, summing up of both unit costs (fixed and variable) compute the total unit cost of digitization

of central library which is Rs. 2532.40. In other words, expenditure incurred per user turns out to be Rs. 2532.40 for digitization of central library, IITD.

Table 4.3.2

Unit Cost of Automation of In-house Operations

2000-2001

S.N.	Activities		Types of Unit Costs (Amount in Rs.)		
			Fixed Cost	**Variable Cost**	**Total**
1.	Acquisition Service		10.45	94.12	**104.57**
2.	Serial Service		30.58	160.62	**191.20**
3.	Processing		21.06	103.62	**124.68**
4.	Reader Service				
	(i)	OPAC and Circulation	14.41	213.12	**227.53**
	(ii)	Bar-coding System	21.87	36.00	**57.87**
	Total		**98.37**	**607.48**	**705.85**

Table 4.3.2 reveals the unit cost of automation of in house-operations. Besides, unit cost of various divisions has also been discussed in the same table. Unit cost of bar-coding system is the lowest cost in this section, while unit cost of reader service's forms the highest which is Rs. 285.40 (Summation of unit cost of circulation system and bar-coding system). The fixed unit cost is Rs. 98.37 while variable unit cost of in-house operations in IITD is Rs. 607.48. Here, variable unit cost is high because salary component has been taken in this head which is a major composition of the variable cost. The total unit cost of this division has come out to be Rs. 705.85. Number of user has been considered as unit of the library (in central library, 4000 are registered member of the library therefore we assumed that all members are using the facilities which have been provided by central library).

Table 4.3.3

Unit Cost of Net-Enabled Services in Central Library, IITD (2000-2001)

S.N.	Activities	Types of Unit Costs (Amount in Rs.)		
		Fixed Cost	Variable Cost	Total
1.	Networking of CD-ROM Database(s)	402.65	27.00	**429.65**
2.	Electronic journals	69.31	403.34	**472.65**
3.	Digitization of Old Journals	45.60	3.60	**49.20**
	Total	**517.56**	**433.94**	**951.50**

Table 4.3.3 shows the unit cost of Net-enabled services (networking of CD-ROM database(s), accessing of electronic journal and digitization of old journals) of central library, IITD.

Fixed unit cost is Rs. 517.56 while variable unit cost comes out to be Rs. 433.94. If one looks into the figures, one finds that e-journals have the highest unit cost. However, unit cost of digitized journals is lowest in this section (digitization of old journals is not an on-going activity. But the first phase of this project has been over so far). Unit cost of Net enabled services work out to be Rs. 951.50. This total unit cost is summation of these three unit costs, i.e. unit cost of Net-based CD-ROM database(s), electronic journals and digitized old journals.

Table 4.3.4

Unit Cost of Acquisition Division

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	10.45
2.	Variable Cost	94.12
	Total	**104.57**

Table 4.3.4 reveals the unit cost of the acquisitions division of central library, IITD. The total unit cost has been divided into two unit cost components - fixed unit cost and variable unit cost. Fixed unit cost of this

division has come out to be Rs. 10.45 and variable unit cost is Rs. 94.12. Variable unit cost is higher than fixed unit cost because variable cost involves salaries of staff which were high in nature. Moreover, variable cost involved maintenance (software) cost and cost of consumable items. Therefore, one could arrive at the conclusion that variable unit cost is higher than fixed unit cost in this division. Even in future, variable unit cost is likely to be higher than fixed unit cost. Total unit cost has been calculated by dividing the annualized total development cost of this division by number of users. The total unit cost is Rs. 104.57.

Table 4.3.5

Unit Cost of Serial Division

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	30.58
2.	Variable Cost	160.62
	Total	**191.20**

Table 4.3.5 depicts the fixed unit cost and variable unit cost of serial services. The fixed unit cost is annualize cost which has been calculated at 6 percent rate of interest. Here units depicts the number of users in the library. Therefore, this can also called per user cost of serial division. The per user fixed cost is Rs. 30.58, which includes the cost of hardware devices (computer, printer, networking) as well as software's costs.

This is quite apparent from the Table that variable unit cost is higher than fixed unit cost. This is due to the fact that salary components, which constitute a major share in annualized total development cost, are kept under variable cost. The variable unit cost is Rs. 160.62. The total unit cost is Rs. 191.20.

Table 4.3.6

Unit Cost of Processing Division

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	21.06
2.	Variable Cost	103.62
	Total	**124.68**

The unit cost of processing division has been described in Table 4.3.6. This Table shows the components of unit development cost. These components are the fixed unit cost and the variable unit cost. Fixed unit cost is Rs. 21.06 which takes into account the cost of hardware devices and software. Fixed unit cost is lower than variable unit cost due to salary factor which constitutes the substantial part of variable cost. Per user variable cost in this division is Rs. 103.62. The summation of both costs constitutes the unit development (per user development cost), which is Rs. 124.68 or 125 for one year.

Table 4.3.7

Unit Cost of Circulation Division and OPAC

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	14.41
2.	Variable Cost	213.12
	Total	**227.53**

Table 4.3.7 depicts the unit development cost of circulation service and OPAC (Online Public Access Catalogue). The fixed unit cost is Rs. 14.41 and variable unit cost comes out to be around 213.12. Here, variable unit cost is higher than fixed unit cost due to the above mentioned reason. Fixed unit cost includes the cost of hardware component which has been annualized (over projected life) at 6 percent rate of interest. The Total Unit Cost is Rs. 227.23.

Table 4.3.8

Unit Cost of Bar-coding System

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	21.87
2.	Variable Cost	36.00
	Total	**57.87**

Table 4.3.8 shows the unit cost of bar-coding system of the library. Reader's service division has two main sections (i) circulation system and OPAC (ii) bar-coding system. Here, unit cost of bar-coding system has been described.

The fixed unit cost is Rs. 21.87, while variable unit cost is Rs. 36.00. Variable unit cost is not much higher than fixed unit cost, as number of personnel employed for this division is not very high. If we sum up the fixed cost and variable cost, the total unit cost of bar-coding system comes out to be 57.87 or 58.

Table 4.3.9

Unit Cost of Reader's Service Division

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	36.28
2.	Variable Cost	249.12
	Total	**285.40**

Table 4.3.9 shows the Unit Cost of reader's service division. In this Table, unit cost, has been divided into two group i.e. fixed unit cost and variable unit cost. Fixed Unit Cost is Rs. 36.28 or 37 and Variable Unit Cost is Rs. 249.12 or Rs. 250. The fixed unit cost is substantially lower than variable unit cost. There may be two reasons behind this. First, Variable Unit Cost is a

major cost component that takes into account several other costs like maintenance, software and salaries paid to the administrative and technical staff and this variable unit cost is substantially high in all divisions as well. Second, the division has been divided into two sections (i) circulation system and OPAC (ii) bar-coding system. If we sum up the development cost of both sections this cost is going to be increased (Reader's Service Division cost is summation of both these costs). Therefore, fixed unit cost may be substantially lower than variable unit cost. The unit cost of this division is Rs. 285.40.

Table 4.3.10

Unit Cost of Network Based CD-ROM Database

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	402.65
2.	Variable Cost	27.00
	Total	**429.65**

Table 4.3.10 reveals the unit cost of network based CD-ROM database. In this division fixed unit cost is Rs. 402.65 whereas variable unit cost is Rs. 27.00 only. The total unit cost of this division (facility) comes out to be Rs. 429.65.

Table 4.3.11

Unit Cost for Accessing of Electronic Journal

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	69.31
2.	Variable Cost	403.34
	Total	**472.65**

As shown in table 4.3.11, fixed unit cost is Rs. 69.31 while variable unit cost is Rs. 403.34. The variable unit cost is higher than fixed unit cost, due to subscription of electronic-journal. Unit cost of this division comes out to be Rs. 472.65.

Table 4.3.12

Unit Cost of digitization of old journals

2000-2001

S.N.	Types of Costs	Amount (Rs.)
1.	Fixed Cost	45.60
2.	Variable Cost	3.60
	Total	**49.20**

Table 4.3.12 depicts the unit cost of digitized old journals. Here, fixed unit cost is higher than variable unit cost due to the amount paid to the casual labour and expenses incurred on hardware components. The fixed unit cost is Rs. 45.60 and variable unit cost is Rs. 3.60. The unit cost of this division has come out to be Rs. 49.20.

Chapter 5

Summary and Conclusion

5.1 SUMMARY

This chapter summarises the major findings of the study and endeavours to relate these findings with some relevant dimensions of the new educational media. This study has been divided into five chapters. The study began with information and communication technology (ICT) and elaborated that revolution in information and communication technology arrived at the onset of the twenty-first century. Information and communication technology (ICT) is a technology which offers smooth flow of information without any geographical barrier through computer, telecommunication and magnetic storage media. The computer is the core of this technology which has gained much popularity compared to others. ICT has proved its importance in every sphere of life. Education being the pivotal point of development has also been affected by technological invasion. Education in general and higher education in particular is adopting ICT slowly and gradually. Universities are responding to these new technologies positively as it promises to change some of the problems of higher education system. For instance literature reveals that universities are facing major financial constraints and are forced to cut down their budget. ICT would be likely to solve these problems by providing a cost-effective system. Information is power in institution of higher learning as these institutions are formed around the information networks. Therefore, every institution has its own storehouse of information. The storehouse of information (library) is also affected by ICT as it has profound impact on it. However, costs of these changes have always been suspect as it is believed that new technology is very expensive in nature. Therefore, this study had been carried out to look at the cost components of digital library keeping the following objectives in mind.

OBJECTIVES

- Role of information and communication in improving the quality of academic sector.
- Functions of a digital library in the institution of higher education.
- Fixed and variable costs involved in digitization of central library, IITD.
- Development cost of various forms of information technology in the digital library and also find out the unit cost of each form.

Chapter 2 of the present study has tried to provide an overview of the digital library. Digital library is a system which provides access to large amount of information and knowledge to many users at one time. This system is not merely used by itself entirely, but is supplementary to the conventional libraries. Digital library offers several facilities to the users. Information available in digital format is changing the facet of library. The CD-ROM is one of the growing storage devices which can store more information in a limited space than any other storage device. On the other hand, growth of electronic journal is also increasing at a fast pace. However, visibility of e-journal appears to be low as the announcement of availability of such journal is often made through the limited electronic source. Electronic journals provide vast amount of information. Moreover, digital data sets, (digitized) old journal of scholarly values, and free links to various electronic resources also provides various kinds of information in digital library. Digital library has great significance in changing scenario since it can manage large amount of information.

Chapter 3 has been divided into two major sections. First section reviews some theoretical and empirical studies with special reference to new educational media. Second section deals with methodology of the present study. Section one shows that though ample literature is available on theoretical perspective of cost analysis, only limited studies could be traced on the empirical verification of cost analysis in educational media. In general, cost

analysis is a process of gathering and organizing information about the costs of a programme. Theoretical studies show that cost analysis may vary from study to study as cost components do not have any uniformity in categorization, even, definition of cost could be changed according to nature of study. In second section, a few empricial studies discussed have links with new educational media. It shows that fixed cost has been higher than variable cost. In case of educational TV, computer etc. these higher fixed costs lead to the economies of scale, as over a period of time, cost of the system would decrease. Studies also analyze the efficiency factor of new educational media, where it can be conveniently said that these new changes make the system more cost-effective as appropriate allocation of resources becomes possible.

The second section of this chapter highlights the research methodology of the study. Central library of Indian Institute of Technology, Delhi (IITD) was approached for the present study, as central library, IITD has positively responded to new information technologies. The year 1998-2001 was taken for the study. Several informal interviews were conducted to know about the functioning of a digital library and its importance in higher education system. We have used different kinds of sources of information during the course of study. These include unpublished and published records of the central library.

The activities of the IITD library can be divided into two groups.

(i) In-house operations, and
(ii) Net-Enabled services.

The central library started automation of In-house operations and Net-Enabled services in 1998. To find out the development cost of these activities, cost components were divided into two types, namely fixed cost and variable cost. Fixed cost constitutes the cost of hardware components, software, furniture and fixture, CD-ROM Database and wages paid to the casual labourers. On the other hand, variable cost is composed of cost of Internet, Electricity, Electronic Journals, consumable items and salaries paid to the administrative and technical staff.

Chapter 4 is necessarily the thrust of this study. It has also emphasised on cost structure of each division of the library. Here cost of all divisions has been discussed at length. For the present study, fixed cost has been annualized. Thus, cost has been calculated by taking risk factor into consideration at 6 percent rate of interest. This chapter has been further divided into three sub sections. First section reveals the annualized development cost of digitization of central library, IITD. The second section of this chapter has emphasized upon the percentage shares of fixed and variable costs in the total development cost. Last section depicts the unit cost of each division where number of users is the unit. Results of this chapter show that fixed cost is lower than variable cost in most of the divisions because salaries paid to the personnel of the library in the digitization process constitute major composition of variable cost. Besides, Internet cost is another important cost which forms around 42 percent of total variable cost. If we sum up both the salary component and Internet cost, it constitutes around 77 percent of total variable cost (around 58 percent of total development cost). Therefore, we may assume that expenditure incurred on Internet and salaries make the major variable cost which affect the total development cost.

5.2 CONCLUDING REMARKS

These concluding remarks are commensurate with the objectives stated for study and the findings of this study have been discussed interchangeably in the proceeding section.

It is now a well-known notion that ICT is influencing every sphere of life and access to information has become easier and economical. The higher education system is also benefiting by these changes. The institutes of higher education (which are considered as major agents of economic development) are also adapting to these new technologies. These technologies are a medium of providing 'borderless education' which shall be more cost-effective, user friendly and time saving. ICT has influenced every aspect within higher

education system from teaching-learning to dissemination of information. In higher education, library has always been an agent of information and in changing scenario this storehouse of information has made breakthrough by providing wider and economical access to information.

As of now, the library has adopted new term, the 'digital library', where easy and fast access of information has been made available to users. The digital library is not a single entity however; it is a supplementary to the conventional library. Digital library contains most of its information in digital format, and electronic journals, CD-ROM, digitized materials are major source of information. Presently, information handling job has become easy and less laborious. Electronic journals are replacing the print media as production and dissemination cost of a electronic journal is less than print journal. CD-ROM is another device which is very user-friendly and can store vast information in limited space. Besides, in-house operations in the library have also become easier with the help of computer. However, cost of these changes is of serious concern for policy makers and planners.

Hence, this study focuses on the development cost of a digital library where ICT has been practised to a large extent. This is an empricial study which focuses on library, IITD. The results show that central library of IITD spent Rs 101,29,651.16 per year for digitization. This figure comprises the fixed cost of Rs. 24,63,670.16 and variable cost of Rs. 76,65,781.00 in the central library. Variable cost constitutes around 76 percent of the total cost while fixed cost around 24 percent of total cost. Total variable cost is relatively higher than total fixed cost because total variable cost includes expenditure incurred on Internet and salaries paid to the concerned staff of library. These two costs are substantially high and constitute major part of the variable cost. Fixed cost (annual) on the other hand, includes the cost of hardware and software and expenditure incurred on furniture and fixture, but these costs are not so high.

A review of existing literature shows that generally fixed cost is higher than variable cost because fixed cost constitutes the cost of hardware, software, furniture and fixture and wages paid to the casual labour. Central library is not following the same trend because casual labourers are hired from within the institution (IIT has a department of computer, technical (development) help are provided by this division without any wages paid to them). The total fixed cost would have been higher than variable cost had the technical (development) cost been added to the fixed cost.

Further, fixed and variable cost structure varies from division to division. These divisions have been divided into two sections, namely automation of In-house operations and Net-enabled services. Cost structure for these sections differ remarkably from each other. Fixed cost of automation of in-house operations is lower than fixed cost of Net-enabled service which involves the cost of highly advanced database, whereas fixed cost of in-house operation service is lower because expenditure incurred on hardware is lower. Total fixed cost of in-house operation is Rs 3,93,579.23, while total fixed cost of Net-enabled service is Rs 20,70,291.43. However, variable cost does not follow the same trend here. Variable cost is higher for in-house operations than Net-enabled services. The study shows that salaries paid to the concerned staff of in-house operations are major costs, constituting around 94 percent of the variable cost of this division. On the other hand, salaries of Net-enabled services constitute around 22 percent of the variable cost of this division.

The unit-user cost of central library is Rs. 2534.40, where fixed unit cost is Rs. 615.96 or 616 and variable cost is Rs. 1916.44. Here again, variable unit cost is higher than fixed unit cost due to above said reason.

The study states that new technologies have shown their impact in higher education system. The libraries/storehouse of information are also benefiting by it. Normally, it is assumed that high costs of these changes are a major bottleneck in the development of digital library. In the context of present

study, however, it can safely be said that the initial cost of development is not as high as perceived; it is the variable cost which is a major cost component and which is higher than fixed cost. Therefore, keeping these findings in view, we propose the following areas for further research:

- A comparative study of costs of digital library and conventional library.
- A cost-effectiveness analysis of a digital library.

Appendix A

Glossary

CD-ROM	An optical disk technology for microcomputers featuring compact disks with a storage capacity of over 500 megabytes. Size 4.7" or 12 centimeter compact disk. Storage 600 megabytes roughly, 1 disk = 400 floppy diskette = 300,000 double spaced pages of the text. CD-ROM disk drive uses a laser devise to read the binary codes.
Central Processing Unit (CPU)	The unit of a computer system that includes the circuits that control the interpretation and execution of instructions. In many computer systems, the CPU includes the arithmetic-logic unit, the control unit, and the primary storage unit.
Computer	A device that has the ability to accept data; internally store and execute a program of instructions; perform mathematical, logical, and manipulative operations on data; and report the results.
Computer Application	The use of a computer to solve a specific problem or to accomplish a particular job for an end user. For example, common business computer applications include sales order processing, inventory control, and payroll.
Computer-Based Information System	An information that uses computer hardware and software to perform its information processing activities.

Data	Factors or observations about physical phenomena or business transactions. More specifically, data are objective measurements of the attributes (characteristics) of entities such as people, places, things, and events.
Database	A collection of logically related records or files. A database consolidates many records previously stored in separate files so that a common pool of data records serves many applications.
DVD-Digital Video Disk	3.0 to 8.5 gigabytes of multimedia data on 8 side of compact disk.
File	A collection of related data records treated as a unit. Sometimes called a data set.
Floppy Disk	A small plastic disk coated with iron oxide that resembles a small phonograph record enclosed in a protective envelope. It is a widely used form of magnetic disk media that provides a direct access storage capability for microcomputer systems. Read/write head. Size 3.5", Capacity 1.44 megabytes, Newer LS-120, 120 Megabytes of storage.
Hard Disk Drive	Combine magnetic disk, access areas and read/write heads into search module. Higher speed, greater data recording densities. Capacity of Hard Disk drive ranges from megabytes to gigabytes.

Hardware	(1) Machines and media. (2) Physical equipment, as opposed to computer programs or methods of use. (3) Mechanical, magnetic, electrical, electronic, or optical devices. Contrast with Software.
Information Technology (IT)	Hardware, software, telecommunications, database management, and other information processing technologies used in computer-based information systems.
Internet	The Internet is a rapidly growing network of thousands of business, educational, and research networks connecting millions of computers and their users in over 100 countries.
Intranet	An Internet-like network within an organization. Web browser software provides easy access to internal Web sites established by business units, teams, and individuals, and other network resources and applications.
Local Area Network (LAN)	A communications network that typically connects computers, terminals, and other computerized devices within a limited physical area such as an office, building, manufacturing plant, or other worksite.
Modem	(Modulator-De Modulator) A device that converts the digital signals from input/output devices into appropriate frequencies at a transmission terminal and converts them back into digital signals at a receiving terminal.

Random Access Memory (RAM)	One of the basic types of semiconductor memory used for temporary storage of data or programs during processing. Each memory position can be directly sensed (read) or changed (write) in the same length of time, irrespective of its location on the storage medium.
Read Only Memory (ROM)	A basic type of semiconductor memory used for permanent storage. Can only be read, not "written" that is, changed. Variations are Programmable Read Only Memory (PROM) and Erasable Programmable Read Only Memory (EPROM).
Server	(1) A computer that supports telecommunications in a local area network, as well as the sharing of peripheral devices, software, and database among the workstations in the network. (2) Versions of software for installation on network servers designed to control and support applications on client microcomputers in client/server networks. Examples include multi-user network operating systems and specialized software for running Internet, intranet, and extranet Web applications, such as electronic commerce and enterprise collaboration.
Software	Computer programs and procedures concerned with the operation of an information system. Contrast with Hardware.
Software Package	A computer program supplied by computer manufacturers, independent software companies, or

	other computer users. Also known as canned programs, proprietary software, or packaged programs.
Telecommunications	Pertaining to the transmission of signals over long distance, including not only data communications but also the transmission of images and voices using radio, television, and other communications technologies.
Web Browser	A software package that provides the user interface for accessing Internet, intranet, and extranet Web sites. Browsers are becoming multifunction universal clients for sending and receiving E-mail, downloading files, accessing Java applets, participating in discussion groups, developing Web pages, and other Internet, intranet, and extranet applications.
Wide Area Network (WAN)	A data communication network covering a large geographic area.
Window	One section of a computer's multiple-section display screen, each of which can have a different display.
World Wide Web (WWW)	A global network of multimedia Internet information sources.

Appendix B

Collections of Central Library, IITD

S. No.	Collection	Total Number
1.	Current Journals	850
2.	Books	1,65,361
3.	Bound Vol. of Journals	95,000
4.	Standard	26,922
5.	Technical Reports	13,384
6.	Theses	2,570
7.	Video Cassettes	1,100
8.	Compact Discs	700
9.	Electronic Journals	1,400

Source: Booklet of Central Library, IITD (2001)

Appendix C

List of CD-ROM Database(s), Central Library IITD

Name of database	Year
COMPENDEX Plus	1992-1998
INSPEC	1990-1998
META DEX	1990-1998
Derwent Biotechnology Abstracts	1982-1998
World Textile	
Business Periodicals Index	1982-1998
MathSci	
Exim India	
LISA Plus	
Induscope: India's Industry Database	
India Business Insight Database	1993-1997

Source: Booklet of Central Library, IITD (2001)

Appendix D

List of Electronic Journals, Central Library, IITD

(i)	Scicnce Direct	http://www.sceincedirect.com/
(ii)	IEEE/IEE Electronic Library	http://www.ieee.org
(iii)	American Physical Society	http://www.aps.org
(iv)	American Institute of Physics	http://ojps.aip.org
(v)	ACM Digital Conference Library	http://ww.acm.org
(vi)	Amcrican Society of Civil Engineers	http://www.pubs.asci.org
(vii)	Nature Magazine	http://www.nature.com

Source: Booklet of Central Library, IITD (2001)

Appendix E

List of Library Software

Libsys ver.4	http://www.libsys.net/
TLMS	http://www.tlms.net/
OASIS/Alice	http://www.softlinks.com.au/
Basis Plus and TechLib	http://www.idi.DL/L.org/
DELSIS/DOS	http://delnet.ren.nic.in/
Suchika	http://www.drdo.org/
SANJAY	http://www.nisat.org/
MAITRAYEE	http://www.cmcitd.com/
Granthalaya	http://www.insdoc.org/

Appendix F

List of Important Websites related to digital library

WWW Virtual Library	http://www.edoc.com
Internet Public Library	http://www.ipl.org
Michigan Electronic Library	http://www.lib.mi.us
Penn Electronic Library	http://www.library.upenn.edu
BUBL Information Service	http://bubl.ac.uk
Argue Clearing House	http://www.clearinghouse.net
Internet Index	http://sunsite.beokeley.edu

Appendix G

Pricing Models of Electronic Journals

Publishers are very much concerned about providing access to their printed material in electronic form, at the same time, economics of e-publishing become major issues for them. Its pricing of e-journal vary significantly in digital era. The publishers make a significant investment in the process of production of a journal which involve many activities like peer-review, administration, editing, layout design, production management and distribution. Some of the activities are permuted for publishing a journal are common to both electronic and paper media, except for production and distribution where the cost involved is relatively low.

Journals are available through the web at varying price models. In a survey of 8001 peer reviewed electronic journals conducted by EBSCO, it was found that 50% of journals are free with print journals, 34% subscription and 16% are available online only without their counter-part. Overall 84% of journals require a print subscription as a prerequisite for online access to their electronic version (Boteler, 2001). The some models are:

(i) The electronic subscription to journals in most of the cases is linked to their printed counterparts i.e. it may be offered free with print subscription (e.g. publications of American society for Physics and AICHE) or priced at a mixed percentage over the print subscriptions.

(ii) Electronic publishers facilitate campus wide unlimited access to subscribed journals on payment of a fixed amount of platform fee. Ex. Elseveri Science (Science Direct).

(iii) Several electronic publishers offer access to the entire range of their electronic journals and other publications packed into one bunch. For instance IEEE/IEE Electronic Library (IEL) and ACM Digital Library offer access to their entire site on subscription permissible.

Similarly, Academic Press offers all journals available on their site for 10% more than the print subscription to library consortia.

(iv) New pricing model have been introduced by publishers and aggregators where a user can search online for a particular article or journals then pay on per article basis (full text).

(v) Consortia provide union strength to negotiate with electronic publishers for the best possible price and rights. The consortia licensing is widely used the world over by the librarian.

(vi) National licenses can also be negotiated with electronic publishers for core collections. Singapore, Taiwan and UK have arranged national licenses for some of the important full-text resources.

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