CHAPTER 2
REVIEW OF LITERATURE
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2.0 INTRODUCTION:

Review of literature is mainly a broad in-depth, critical & systematic examination and analysis of scholarly publications as well as unpublished scholarly literature, etc. Review of literature is crucial step in research process and in fact it is the starting. It refers to a widespread, in-depth & organized investigation and study of publications including Journals, periodicals, research studies, etc. relevant to the subject of research project.

The base of every research study is the past knowledge accumulated from previous studies. It is an outcome of constant human endeavors. No research study can progress in isolation of other studies done in similar field. Review of related literature helps researcher in determining the main findings, trends areas of debate and controversial areas of neglected and suggestions for additional research. It can help in organizing thoughts, giving shapes to ideas and achieving new insights. It is not enough to test one’s own ideas. Therefore, given a chance to access his or her ideas in the context of others and replicate external or modify them in terms of establishing thinking.

Considering this fact, in as part of the research process the researcher has reviewed of the available study papers, articles, published in various national & international journals, periodicals etc. In the subsequent paragraphs an attempt has been made to review the literature pertaining to ICT infrastructure in higher education institutions, its benefits and its management and published literature related to ICT security in higher educational institutions which are the major focus areas of the present study. Therefore the literature review has been divided into two parts that is, reviews of literature related to ICT management and reviews of literature related to ICT security in higher educational institutions.
2.1 REVIEW OF LITERATURE PERTAINING TO INFORMATION & COMMUNICATION TECHNOLOGY IN HIGHER TECHNICAL EDUCATION INSTITUTIONS

1) A study paper by C. Sanga, A. Sife, E. Lwoga\textsuperscript{16} have opinion that the application of information & communication technology has changed the organization & delivery system of higher education. Through the study paper authors have highlighted the contemporary and latest learning & training technologies taking into account their academic, financial cost and technical effects. The authors have also discussed the challenges related to incorporating these technologies in higher educational institutions. Authors have suggested some best practice approaches for addressing each of the challenges. Authors have is a former opined that, the socio-economic and pedagogical factors that have driven the higher educational institutions to adopt and implement information & communication technology in the entire education process. This includes greater information access, the communication, pedagogical improvement etc. Authors have also stated that information technology hasn’t been implemented to a great extent in many higher educational institutions in the developing countries, because of economic and technological barriers\textsuperscript{16}.

2) A study article by C. N. Mahopatra\textsuperscript{14}, titled, “Educational Planning and Administration”, published in the Journal of Higher Education, Volume. 2, Number. 4. In this study article, author has discussed the application of information and communication information technology in management and Administration process of higher educational institutions. Author has opine that, computerization and implementation of information & communication technology in management of higher educational institutions proved useful in maintaining stock records and flow statistics in education. Author as further stated that, adoption of information and communication technologies have always been found helpful in and in reaching curriculum and computer assisted instructions provided flexibility in the curriculum.\textsuperscript{14}

3) A study paper by N. D. Oye, N. Aiahad, and A. B. Raheem\textsuperscript{38}, through their study paper have examined the acceptance, awareness, & adoption of information & communication technology in higher educational institutions. The study was conducted at the University of Jos Plateau state, Nigeria. Through the study
authors have achieved objective which is to determine the level of awareness of
information and communication technology by the respondents. The result of the
study shows the level of anticipated adoption of ICT as per the respondents and
performance expectancy which authors take as the most influential factor for the
acceptance & use of information and the communication technology by the
higher educational institutions.

Institutions”, published in the 3\textsuperscript{rd} Conference On Science And National
Development proceedings, 2008, states that numerous higher educational
institutions have employee information & communication technology tools for
improving academic as well as management activities. A random sample of 15
higher educational institutions comprising of five colleges was chosen to
conduct study work to ascertain the state of ICT infrastructure in higher
educational institutions. Tested and reliable questionnaire was used to capture
data on how information and the communication technology infrastructures in
higher educational institutes are maintained or managed. The result of study
generally shows that, the mean time to failure of information and communication
technology tool is high. The model integrates ICT infrastructure management,
security management and service management for efficient maintenance and
management of information and communication technology tools and resources.
It was observed that, firstly the trained ICT support staff were insufficient (55%),
and secondly the investment in ICT infrastructure in case of higher educational
institutions is low. Thus, authors have concluded that ICT tools are not amply
managed in higher educational institutions.

5) An article by A. Youssef, & L. Ragni\textsuperscript{8}, Published in RUSC. Universities and
Knowledge Society Journal, The authors have based their study on the 3 basic
levels of educational digital divisions based on: ICT equipment used, usage
divisions and performance of ICT in education. The study is based on European
higher education institutions. The study also covers the explanation of the
diversity of usage of ICT amongst countries and universities.

Authors have stated that Strong government policies have reduced the digital
divisions amongst higher education institutions but they have also pointed out
that the ICT equipment available at home and those available at institutions still bear a gap. Moreover, development of new technologies on daily basis is creating a huge pressure on ICT.

With regards to the Usage division authors have found that every University, student and or teachers have different ICT usage motives and goals. The intensity and time devoted of usage, thus, also shows varied trends. Depending on student ability and type of contents available country and university-wise is also a cause of Usage divide.

Authors have pointed out that even though students and teachers are using ICT but organizational setups of higher education institutions are not supporting. The authors have strongly advocated training programs of staff.[8]

6) A paper by B. Singh, & D. Kaushik[11] in their paper published in published in International Journal of Science and Research (IJSR), wherein the author has studied the impact of ICT on teachers engagement. The study sample was of 324 teachers from across India. As per author’s findings and statistical analysis ICT was found to be positively associated with Teacher engagement for pedagogical purposes. One of the foremost limitations of this study is that the respondent teacher sample has not been proportionately clustered region-wise looking at the vast population and size of India. Thus, this representation is not been correctly made as certain regions like metropolitan cities are much ahead in the use of ICT whereas rural areas are still deprived of ICT facilities.[11]

7) A research paper by C. Purkayastha[15] titled ICT: FOR BETTER EDUCATION, states that ICT is providing the college teachers a means of developing relationships with the students. The paper tries to address the problems faced by students as well as by the teachers in the usages of ICT in university of Mumbai affiliated colleges. The sample includes 160 students and 40 teachers. It was found that ICT has maximum penetration in Science stream. Another important finding from teacher’s responses is that most of them feel that GOOGLE can never replace the teacher’s place. Most teachers felt that they had time constraint as they had to work a lot or Credit based syllabus. It was also revealed that only 30% teachers said that they were not skilled in ICT technologies. But the main
point of concern or teachers was that they felt that creating digital teaching content takes more time.

Students on the other had complained of Poor ICT infrastructure in class rooms and in the library coupled with poor internet connectivity. Many even complained of poor PPTs by teachers. Author concluding opinion is that if conventional teaching methods are combined with ICT skills teaching, students can grasp more knowledge and can perform better in their academics. [15]

8) A Study Paper by F. Shafi-Ullah & S. Roberts\textsuperscript{23} paper published in the Pakistan Journal of Social Science, Volume 7, Number 4. This paper was also presented at International Conference on Academic Libraries, University of Delhi (North Campus), India. This study explores the current scenario of library automation in public sector universities in Islamabad(Pakistan). The study covers a number of issues ranging from education policy and library automation to adoption of international standard in library automation in these universities. Authors identified a number of issues that have slowed down the pace of ICT based library automation which includes bureaucratic management hurdles, adoption of ICT at a slow pace, financial funding related issues, infrastructural issues in higher educational institutions, to name a few.[23]

9) A study Paper by R. L. Venezky & C. Davis\textsuperscript{41}, titled, “Quo vademus? The transformation of schooling in a networked world” created for Organization for Economic Co-operation and Development [OECD] used case studies as one of the main tool. Their findings have also found place in many publications of renowned Kogan Page Publishers, London, UK. This study was conducted as a part of a worldwide study that examined 174 case studies(covering 30 countries) of ground-breaking pedagogical practices using ICT. Two very significant goals of this study were:(i) to understand the ways in which ICT could be correlated with academic innovation, and (ii) The growth of ICT in education. [41]

The studies attempted to establish an association amongst successful implementation of innovation in education and successful use of ICT as a social group. Authors have stated that, it is the rapid &persistent implementation of latest and novel ICT technologies in the higher education system that has raised
the outlooks towards ICT’s potential for a valuable contribution towards the improvement of education.

The authors’ state various nations have created clear policies have been for the incorporation of ICT based technologies into their educational systems. Some important tasks mentioned in these policies w.r.t. educational institutions range from installing computer networks, connecting these institution’s networks to the Internet, and train the teachers to make them adapt to ICT. In the opinion of authors, ICT infrastructure, technologies including connection to the internet is highly recommended in educational institutions. This study also covers the identification of various factors that affect successful implementation of novel pedagogical practices using ICT technologies in higher educational institutions.

10) S. Sarkar\textsuperscript{46} paper titled The Role of Information and Communication Technology (ICT) in Higher Education for the 21st Century, as published in Science Probe Journal, states that ICT’s role in education is more student-centric and this creates some strains on some teachers and learners. The paper further states that ICT in higher education is useful for educational development as well as for encouraging social and economic progress of the nation. ICT is very important for research departments of higher education institutions especially because of its data processing role. The author further states that elaborates some mistakes associated with introduction ICTs into teaching the most important and worth noting is that learning technology is introduced without reviewing student needs and without verifying the content availability and as per country or region where it is implemented. Author has stressed on having suitable telecommunication networks and ICT policies. It has also stressed that government must develop policies for effective ICT& media deployment. The authors have not discussed anything about what types of technologies are available for teaching.[46]

11) An article published by Global Economic Symposium-GES\textsuperscript{25}, titled Effective Investments in Education, published online as part of Symposium 2012. It particularly discusses the investment in education. The authors state that “the only thing more expensive than investing in education is not investing in education”. The reason they give for this is that inadequate education produces
high costs because of higher public spending to control crime, health, and economic growth.

The authors’ further state that it has been observed that whenever there is economic slowdown, it’s the education budget which the first one to be decreased which in turn restricts the available resources. Authors stress on the fact that intelligent financing concepts for education should be created which are based on needs and specific background and not on distributing untargeted subsidies. [25]

12) C. Fried, in his paper concentrates on the use of laptop by students while attending lectures in the class and examines its effects on the student learning. It discusses the very logic behind allowing students to use laptops in class rooms. For the purpose of research, survey of students was conducted with a sample size of 137 students. These students were being taught in classes which had Wi-Fi facility. It was observed that students who used laptops in class not only used it for study purpose but also at the same time were involved in doing some other work on their laptops. This according to author is, thus, a distraction and a waste of time. This distraction is not only limited to the student user but also other fellow students sitting in the classroom. In fact, considerable number of students admitted that they, while attending lectures, were using their laptops for things other than taking notes in the class. Students also negatively related to the use of laptops against several measures of learning.

Author has also cited various other studies and cases where educational institutions have totally banned laptops in classes due to various reasons. [12]

13) A research paper by N. Snehi, on one hand, tried to highlight the various opportunities that can be exploited by incorporation of ICT in various areas of higher education in the present-day scenario. On the other hand, it has also strived to understand the challenges posed while doing so. The author has advocated use of formulation of Policies and Strategies to mitigate the various challenges and obstacles which come in the way of ICT’s implementation in educational institutions. The author strongly puts great expectations that future developments in ICTs, if integrated with education sector, will certainly transform the higher education system. Author has pointed out that lots of
western universities have digitized their library titles while others have started providing day to day instructional lessons/materials online.

Author also points out even after satisfactory increase in access to technology in the educational institutions; still the incorporation of ICT into the educational curriculum is deficient. One of the reasons for this is the lack of trained teachers along with lack of inspiration among teachers to adopt ICT-based pedagogy approaches. [39]

14) A Book by B. Mahajan &S. Majumdar10, Titled “Educational Administration in Mizoram: Structures, Processes and Future Prospects”. This book is an outcome of the second survey of all India educational administration, and conducted by National Institute of Educational Capital Planning and Administration (NIEPA) in the year 1990–91. The main goals of the study were i) to understand the presence status of ICT adoption and computerization of management and administrative functions of higher educational institutions in terms of structures systems and academic functions at various levels, ii) to study the experiments, innovations and changes in ICT and computer system and iii) to identifying major issues and future tasks of educational planning and management of ICT infrastructure of higher educational institutions. A detailed analysis is done on the prevailing ICT infrastructure and education system, status of computerization and management/Administrative and academic activities etc. are statistically presented by the author.[10]

15) A study paper by K.B. Powar33 titled, “Online Education: The Quality Imperative” states that the most crucial aspect of success of the use of ICT in the higher education institutions is the quality aspect – which has been discussed by the author in this article. Author has covered various quality issues with reference to ICT infrastructure management, student support services and staff development for assigning of management plans and delivery of online education.[33]

16) A case-study based paper by K. Fisher31 examines the evolution of technology-enabled active learning environments. The author has also tried to figure out the reasons for their appearance. It focuses on finding out how such environments are able to enhancing teaching and learning outcomes.
The author used case studies for the same some of these included MIT’s Aeronautical School’s pedagogical model called CDIO (conceive, design, implement and operate) model, TEAL model for teaching of Physics at MIT and The Australian Science & Mathematics School (A.S.M.S).

The author found that clearly, the TEAL model involved both quantitative & qualitative examination methods. The author opined that TEAL was best suited for qualitative studies from both teachers prospective and students prospective. Also, TEAL approach was found to be more realistic in creating life-long learners as equated against the traditional classroom model. [31]

17) A study paper by S.S. Motebennur Dr, studies the Integration of ICT in Higher Education w.r.t. Dharwad District in the state of Karnataka. This paper attempts to analyze the role of Information & Communication Technology (ICT) as a factor for enhancing the management and an illustrative quality of higher educational institutions. The study covers 25 higher educational institutions affiliated to Dharwad University. It has been concluded that adoption of ICT as a strategic management tool is a good indication. The findings of the study shows that ICT has been successful in predicting the future of new technology for the purpose of management and administration of higher educational institution. This is certainly going to improve the quality of education. The results of the study revealed the close association among the factors like relative advantage of information and communication technology and management quality and education quality. The study also showed that how information and communication technology has received extensive recognition as a strategy for making an improvement in the quality of education as it gives acquired relative advantage through compatibility and demonstrability. [47]

18) A study paper by D. Nicol & M. Coen published by the Strathclyde University (UK). Authors have stated that huge funds have being for implementation of new information & communication technology to enhance the teaching-learning process & to refine the management functions in higher education institutions. In the opinion of authors all efforts in the recent past to devise an integrated cost benefit model to appraising ICT investment options from institutional perspective have shown very low progress. So, the authors have described a model that has been developed to enable evaluations of the costs and benefits of
utilization of information & communication technology. The authors have also
highlighted and discussed the strengths & weaknesses of this model.[21]

19) A study paper by D. Krishnaveni, & J. Meenakumari[20], published in the
International Journal of Environmental Science and Development, volume 1,
number 3. Authors have stated that phenomenon growth in the higher education
segment has turned the administration & management of this sector quite
complex. According to some studies, the proper implementation of information
on the communication technology resulted in the reduction of management and
administrative complexities and enhance the overall administration and
management of higher educational institutions. Through the study authors have
identified the certain least functional areas where Information & Communication
Technology (ICT) has been introduced for the administration and information
management purposes in higher educational institutions. Authors have also
identified the various factors that affect such functional areas.[20]

20) A study paper by C. Maki[13], published in the Journal of Online Learning and
Teaching, volume 4, number 3. The author discusses various areas related to
higher education’s management and administrative sub-systems. These include
management and administration of human resource, students, finance, general as
well as administration of other resources relevant to higher education sector.
Thus, authors have equated the information & administration of management
related activities managerial activities w.r.t. higher educational institutions.
Authors are of the opinion that ICT is playing an important role in supporting
powerful and efficient management and administration of the higher education
sector. [13]

21) A study paper by Z. Hossein[52], published in International Journal of Education
and Information Technologies”, volume 2, number 1. states that Information &
Communication Technology (ICT) has provided quite a few opportunities for
educational administrators to conduct their responsibilities efficiently. Thus,
changing the nature management of higher educational institutions as well as
higher education itself. This is because the ICT has transformed the way the
information can be transferred, stored, retrieved & processed by people who
either the employees, or are the students or are the other stakeholders / 3rd parties
who interact with that particular higher education institution. In the opinion of
the author ICT increases the managerial effectiveness and efficiency of the higher education institutions.[52]

22) A study article by A. Kumar & A. Kumar⁴, published in the Weekly Journal of Higher Education In India, Association of Indian Universities, volume 43, number 30. Through the study authors have highlighted the importance of information as a significant tool that would useful to the Indian higher educational institutions. Through the study authors have opined that, Information & Communication Technologies raised the scientific level of teachers, learners and managerial staff belonging to higher education institutions.[4]

23) A study by G. Suri²⁴, published in this special interest group of CSI. Author has conducted a comparative study of universities in Spain and India. Author is of the opinion that universities in both these countries have seen a tremendous change and this change is attributed to the development of innovative communication technologies. Author has further stated that, user satisfaction is widely used as measure of information and communication technology success. Author has provided conceptual model for implementing effective information and communication systems for higher educational institutions. Author has observed that Information & Communication Technologies (ICT) have proven to be useful in the management & administration of the higher education institutions and have specially supported the business and academic processes & strategies. [24]

24) A study paper by U. Toro Gulavani & M. Joshi⁵⁰, published in the International Journal of Management Technology, volume 3, number 1. This study strives to study the role of ICT in relation to the enhancement of quality and management of education in higher education sector during the period from 2004 to 2011. Author have concluded that Information & Communication Technology (ICT) has in fact proved itself as tool noteworthy to enrich the quality of education as well as the quality of management & administrative functions in the higher educational institutions. ICT facilitates the sharing of best practices & best course materials for the higher education. Authors have also stated that, information and communication technology also produced a significant changes and transformation in the management and administrative functions of higher education is institutions.[50]
25) A study paper by N. Ahmad\textsuperscript{37}, the author has opined that, rapid and continuous changes in the society places new expectations on educational system and its management. Author has further stated that educational institutions are not only burdened with gathering & maintaining the data by concerning teaching and non-teaching staff members working in the institutions but also have to spend considerable time on other works. This problem can be overcome by using Information Communication Technology (ICT). With the help of ICT the institutions can develop their institutional information management system. Thus, Information & Communication Technology can play a major role in educational institutions management especially in the fields of such as learner and pedagogic, personnel, infrastructure & general administration.\textsuperscript{[37]}

26) A study paper by K. Balasubramanian, W. Clarke-Okah, & J. Daniel\textsuperscript{29}, titled “ICTs for Higher Education”, the study paper presented in the UNESCO world conference on higher education organized in the Paris in July 2009. Authors have examined various roles that information and vacation technology can play in enhancing the 3 important elements that constitute the major part of Information in higher education institutions i.e. (i) Research, (ii) community service, and (iii) Teaching. Authors have the emphasized on the need for an institutional and national policies to support the utilization of information and communication technology in research functions. Authors have also highlighted the role that Information & Communication Technology can play in supporting the expansion and growth of higher education institution in the communities. The study also cover show ICT can affect the administrative functions of the educational institutions and discusses the application strategies related to the utilization of ICT tools in higher education institutions. Authors have concluded that information and communication technology not only strengthens the infrastructure of the higher education, but also increases the power to implement the academic ideal that knowledge is important.\textsuperscript{[29]}

27) A study paper by U. Fredriksson, E. Gajek, & G. Jedeskog\textsuperscript{49}, presented at the ECER, in Vienna (Austria). The paper concentrates on European e-Learning Forum for Education 2 (ELFE2) as a means to study and understand the strengths & weakness of using ICT in education and the related factors. Authors have found that the two main areas where the Information & Communication
Technology (ICT) w.r.t. educational institutions is mainly put into use is (i) Administration, and (ii) Management. Also these two are mostly related to student administration, staff administration of resources, internal and external communication and others administrative sectors of higher education institutions.[49]

28) A study paper by A. Bakeer, & M. In Wynn, this paper presented in the Ninth International Multiconference on computing in global Information technology. This paper explores & examines the Information & Communication (ICT) technologies used in universities in the country of Libya. With the help of system profiling and process map, the author has examined the current and possible uses of technology in the said area. It also studies a new model put forward and applied in the Misurata University for accessing information. Through the study authors have found that in the selected Libyan universities under study, ICT technologies usage is limited and that they are used in a very uncoordinated manner. It is also observed that there is a lack of ICT-based communication channels like e-mail, web based media, and the communication networks are disjointed. Also there is a lack of knowledge & awareness regarding ICT among the management staff and there are no specific plans for development and implementation of ICT.[1]

29) A study paper by K. Bingimlas, published in the Eurasia Journal of Mathematics, Science and Technology Education, volume 5, number 3. In the study paper author analyzes the possible barriers to ICT integration in the area of education in science field. The author found that teachers have a strong desire to integrate Information & Communication Technology into the higher education system. The author further found that there are barriers in doing so which include lack of confidence, lack of access to resources, and the lack of capability. To counter these barriers the authors have provided the suggestion for those people who have been entrusted with the responsibility for the integration ICT into higher education. Author has concluded that Information Communication Technology gives a positive impact in teaching-learning and in management and administrative functions of higher education.[30]

30) An essay Essays, UK, published on UK essays.com titled The Computerization of Education. The author states that ICT helps in improving the
effectiveness of all types of educational activities by using the it’s various tools and technologies. It also provides excellence in training and alters the thinking pattern as per the requirements of the information society. The author advocates the use of multimedia to enhance the visual and graphical methods used in the teaching-learning process. ICT is also playing an important role in providing Supplementary & learn-from- home education. The students are able to communicate with each other through internet along with completing their assignments including participation in online projects and research work. The author finally states that ICT boosts student's ability in the area like datamining, analytical thinking & strengthens their research skills because ICT is able to provide vast amounts of information to them. ICT provides timeline for assignment completion which teaches students the art of time management and the value of team work cooperation. [22]

31) A study paper by A. Mandal & J. Mete5 published in Bhatter College’s Journal of Multidisciplinary Studies, University of Kalyani, West Bengal. In the opinion of authors, there is a direct impact of the progress and enhancements in Information & Communication Technology (ICT) on higher education. Authors have stated that, ICT has deep effects on the entire higher education system specifically especially in areas related to administration and management, access, equity, quality efficiency, and pedagogy. Authors have stated that diffusion of ICT has brought of lots of opportunities but the optimal utilization of these opportunities in higher education system present number of challenges for higher education institutions. It is these opportunities & challenges that the authors have strived to study.[5]

2.2 REVIEW OF LITERATURE PERTAINING TO INFORMATION AND COMMUNICATION TECHNOLOGY SECURITY:

1) A study paper by D. Ghindici, G. Grimaud, I. Simplot-Ryl, Y. Liu, I. Traore19 published as part of: IEEE Conference on Local Computer Networks - LCN. Department of Electrical and Computer Engineering, University Of Victoria. Authors have focused on the privacy properties and security breaches arising from user’s interactions with the system. Authors have opined that, w.r.t. dealing with software security, the contemporary approaches attempt at fixing defects in software security only after they have already been abused. Only
rigorous practices, tough security requirements and design specifications, testing and maintenance phases can increase the user’s confidence. The authors have proposed an integrated security and validation framework for building secure applications, which combines quantitative design, security analysis techniques with the static program analyzer to tracks unsafe information vulnerabilities.[19]

2) A study paper by N. Aher[36], titled, “Campus Security Using Honey pot”, published in UACEE International Journal of Advances In Computer Network And Its Security, volume 3, number 2. Author has discussed the computer and network security. In the opinion of the author, due to increased incidence of breaching network security, the significance of this network security and services at higher educational institutions has never been higher than it is now. Nowadays, higher education institutions are demanding more and more network services and exchange of the potentially sensitive information within these services. Through the study paper authors has highlighted a new technology known as Honeypot. The purpose of this technology is to detect and learn from attacks and use that information to improve security. Author has stated that Honeypot is a new network technology which is much better than the traditional passive network security defense models because of its data control and data capture model function. Thus, will provide effective security for campus network.[36]

3) A study paper by L.Gordon, M. Loeb, L. Zhou[33], published in Journal of Computer Security, volume 19, number 1. The Authors tried to resolve problems related to information security breaches that have been brought forward by previous studies. Authors have found that, the impact of the board class of information security breaches on stock market returns. According to the author, if we classify breaches in terms of primary effect including confidentiality, integrity and availability, it was found that attacks associated with the breaches of availability are found to have negative effect. Authors also found that in recent years average information security breaches implicated lesser costs including financial ones. In fact, post Authors have also observed that post 9/11 attacks, there has been a significant downward shift in the impact of security breaches. This according to authors might have happed because of introduction of more effective remediation and disaster recovery plans to name a few.[33]
4) A study paper by M. Barrett, K. Garrety, and J. Seberry, Authors have discussed the computer security and breaches of security. The study focused on ICT professionals rather than regular users of ICT. Authors have stated that with increase in computers and computer network the concerns regarding security breaches have increased phenomenally. Authors have further stated that people have failed to understand human element in ICT security especially regarding their perceptions regarding their responsibility towards ICT security though they are much more aware regarding the technological solutions for ICT security. The authors found that ICT specialists to tougher on themselves than what was expected by management from them computer security as they took their jobs seriously. But the author also found that they felt misunderstood and under-appreciated by their management. Also ICT specialists think that other staff members in the organization are not capable of handling ICT security hazards.

As a solution, the authors have advocated the formation of “responsibility structure maps”. Authors have found that ICT staff seem to have a strong sense of their professional responsibility in relation to computer security breaches but such staff think that.

5) A study paper by S. Guillaume, H. Carlo, A. Matthieu, J. Marianne, & M. Romain, presented in the 9th International MultiConference on Computing in the Global Information Technology. In this study paper authors have explained a risk assessment tool called RISK–DET. This tool includes an ICT risk awareness aspect which is supported by an application called Voozie2.7. The authors have also explained the role of cognitive sciences in ICT security awareness. Authors concluded that it is necessary though training can be given for ICT security risk reduction but with passage of time the effects of training will certainly fade away. A solution to this problem is that the RISK-DET tool shall be based on a core system using versatile contents that will be set at runtime.

6) A study paper by D. Bhatia, titled, “Network Security”, Student Publications. In this study paper author has discussed network security along with various issues and problems details related to it. Author has stated it must be ensured that there is security of networks and related services from unauthorized alteration, damage or exposure and that there is provision of assurance that the network will performs its crucial functions correctly and that there are no
harmful side effects. Author has also discussed the International Standards Organization and open systems interconnect (I.S.O/O.S.I) model to explain the concept of network and internet. Author has highlighted the kinds and cradles of unauthorized access, network threats, executing commands illicitly, confidentiality breaches, data digging and data destruction etc.[18]

7) A study paper by A. Shrivastava7, titled, “ICT Penetration & Cyber Crime In India: A Review”, published in the International Journal of Advanced Research in Computer Science And Software Engineering, volume 3, number 7. In this study paper, author has discussed the information and the communication technology penetration and prevalence of cybercrimes in India. Author has used data from various sources pertaining to Information Communication Technology penetration, cybercrime trends and prevention measures towards curtailing cybercrimes, etc. Findings of the study depict that ICT penetration, utilization of internet and internet related crimes are on the rise in India. Author has observed that most of the cyber crimes are being committed by young persons. Author has further stated that most cyber crime either go unreported or the conviction in such cases is very poor. Author has opined that, it is because of lack of security awareness among users, developers as well as administrators that vulnerability exists in cyber sphere. Authors suggest that promotion of information security awareness is an ongoing process.[7]

8) A study paper by B. Faruque, A. Haolader and M. M. Rahman9, published in the International Journal of Innovative Research in Science and Engineering and Technology, volume 2, number 10,. ICT itself has been one of the foremost reason behind many problems. According to the author huge amount of money is lost annually because of cyber crime. Universities and other higher educational institutions are not excluded from this list. To solve this problem, the Universities and other higher educational institutions must implement ICT security in their campus. Authors are of the opinion that higher educational institutions ICT security can affect their academic progress. Thus, there is a strong relationship between academic activities and information communication technology security. [9]

International Counterparts”, Directorate General For International Internal Policies, Policy Department, European Parliament. Through the study authors have provided a review of the classification of security incidents & breaches. Authors have summarized the efforts European Union has taken to address network and information security issues. Authors do fear that incident notifications outcomes may not be accurate due to certain overlapping regulation and definitions of covered entities. Authors have recommended that, it would be better to clarify what kind of incidents a particular directive is aimed to address.[44]

10) A study report paper by R. Tehan⁴², titled “Data Security Breaches: Context and Incident Summaries”, Knowledge Services Group and prepared for members and committees of US Congress. The author has stated that, in the USA 15% of all Internet domain names is owned by educational institutions. The report presents statistics of Educational institutions effected by ICT related breaches between the years 2000- 2007. The people who were effected were most students and employees of educational institutions. The data stolen was mainly Social security numbers, addresses, financial data, date of births to name a few. In the opinion of author, more than half of the security breaches occurred at the institutions of higher education. While discussing the security breaches as breaches author has highlighted some of the important data security breaches and points out the fact that in USA higher educational institutions have lost valuable data many times just because of inefficient and insufficient network security measures. Author has further stated that, in India the situation can be fatal as such developing countries suffer from technological as well as financial problems.[42]

11) A study article by A. Dodge², titled, “Information Security Breaches In Higher Education Institutions”, The author has published this study as Educational Security Incidents (E.S.I.)Year Review report for the year 2009. Through the study author has examined various information security incidents which have occurred at the colleges & universities around the world. Author has stated that rate of information security incidents reported, in terms of number of incidents and the information exposed by higher educational institutions, have decreased as compared to year 2008. [2]
12) An article in Wikibooks, titled, "Information Security In Education CIPA, FERPA, HIPAA and The School Information Security Plan". This article states that the US Federal government has given certain guidelines that schools must comply with. These include the Children's Internet Protection Act and the Family Educational Rights and Privacy Act 13. In the report it is stated that there are federal laws to address problems like access to offensive content over the Internet on school and library computers. These laws also impose certain requirements on any higher educational institutions that receives funding for internet access or internal connection from the E-Rate program, which is funding program for making available affordable technology of communication for eligible higher educational institutions.[51]

13) A study paper by A. Jones, T. Martin, titled “Making Information Security Accessible Acceptable to the User” presented in the proceedings of the First International Cyber Resilience Conference, Edith Cawan University, Australia. Through this study paper the authors have discussed how the technologies, social and economic changes and some other issues may affect the end-user's perception and the way the user interacts with the technologies. In the opinion of authors the problems related to the security of information that is processed & stored using ICT system still don’t have a satisfactory solution though software developers, system architects and managers are continuously trying to improve it. But the challenge is that conditions, the threats to the information, the technologies in use are changing at a pace is much faster than can be efficiently addressed.[3]

14) A study paper by R. Broadhurst, L. Y. C. Chang, titled “Cyber Crime In Asia: Trends And Challenges”, Handbook Of Asian Criminology. In this study paper authors have discussed the cyber crime and its impact in Asian countries which considerably increased along with the rapid growth of Internet use. The solution to this problem relatively underdeveloped and authors have concluded that complete solution will not be available early. The study further looks at the law enforcement response in the Asian countries. Authors have further opined that, as new technologies like cloud computing, smart phones and social media are developing, encryption convention and technologies should also be updated.[40]
A study paper by M. Jones\textsuperscript{35}, titled, “An Evaluation Of privacy And Security Issues at A Small Universities”, Published in The Technology Interface Journal/Winter Special Issue 2009. Through the study author has highlighted the security and privacy issues related to University of America. Author has focused on the privacy and identity theft and its prevention. Author has also discussed the other issue is the revolving around network security and like content filtering etc. through the study author has found that, employees hired, who handle personal and sensitive information, have not received any proposed proper training regarding privacy and security of information and the communication technology. The authors have recommended mandatory training session on privacy and security for all fulltime and part-time employees, including student workers who work as lab facilitators and teacher assistants.[35]

2.3 REVIEW OF LITERATURE PERTAINING TO ICT FACILITIES PROVIDED BY COLLEGES IN INDIA AND INTERNATIONALLY:

In this section we look at the ICT infrastructure facilities that have been offered by some of the well-known higher education institutions from around the world and India. The Researcher has collected this data from their websites and so the information from colleges may be limited.

1) **St. John’s college** (University of Cambridge)\textsuperscript{48}. The facilities offered by this college includes:
   
   a. Computer rooms,
   
   b. Scanners and printers in labs,
   
   c. Public access points,
   
   d. File storage facility,
   
   e. High-speed network connecting rooms and hostels.
   
   f. ICT Help Desk
   
   g. Disaster recovery service for data recovery if computers fail.[48]

2) **Reading College\textsuperscript{43}**. The website states that Reading College UK provides the following ICT facilities:
   
   a. PCs for students throughout the college.
b. Classrooms with:
   i. dedicated PC,
   ii. digital projector,
   iii. smart board.

c. iPads, laptops and touch screen PCs are also available.[43]

3) **City College Brighton & Hove** (UK)\(^{17}\) states that at its Resource Learning Centre it has provided:
   a. Wide range of resources like
      i. eBooks,
      ii. DVDs,
      iii. More than three thousand videos available as streamed media.
   b. Scanners.
   c. workstations,
   d. Printers (both black and white and colour),
   e. Photocopiers [17]

4) **IIT Delhi**\(^{28}\). India’s premier institution IIT Delhi has some of the best ICT infrastructure in the country. The salient features includes:
   a. State-of-the-art dedicated Computer Services Centre provides:
      i. High level computing through PADUM: Hybrid High Performance Computing Facility.
      ii. Email facility for staff and students.
      iii. Software Repository for software like MATLAB, etc
      iv. Wi-Fi network in campus,
      v. Storage space on servers,
      vi. Student’s Home directories,
      vii. Internet,
      viii. Encryption services,
ix. Cloud computing and storage,

x. VPN, etc.

b. A well-documented and publically available ICT usage policy.[28]

5) **IIT Bombay**. As per the brochure of the institution, IIT Bombay’s computer centre provides computational facilities to users in the institute. IIT Bombay offers:

a. Pan-campus Fibre optic high-speed backbone network.

b. User Accounts high-end computational server for all faculty members, students and staff.

c. Network connections in Classrooms, laboratories, faculty houses, and student Hostels.

d. Application Software Cell (ASC) is an in-house low cost software development facility. Software applications developed include:

   i. Academic software for admissions, course registration, grading and scholarships,

   ii. accounting and payroll,

   iii. Administrative and HR software,

   iv. Software for Library, estate and hostel management, security and hospital administration, etc. [27]

6) **IIM Ahmedabad**. IIM Ahmadabad, has provided A state-of-the-art computer network with more than 2000 PCs connected with campus-wide Fibre optics backbone. All building on the campus, student rooms in hostels, faculty cabins, classrooms, management development centre, administrative offices, computer lab, etc. are connected with this Fibre optic backbone.

Other ICT facilities include:

1. Password protected campus-wide Wi-Fi high.

2. A Firewall for security.

3. Storage server which can be accessed from outside using VPN for teaching staff only.
4. Large Server farm consisting of high speed servers providing:
   a. Internet access, and
   b. File and print services.
5. E-mail facility is managed through Google.
7. Network printers in Student dormitory with web based print billing software.
8. Software packages including language processors, statistical, math programming, simulation, project management, CASE, and ERP packages are available to the students and faculty for their academic and research work.
10. Classrooms equipped with a computer node, a projector, and a DVD player
11. ISDN based video conferencing capability.
12. IIMA website provides:
   a. Payment gateway where students can pay fees, etc, and
   b. Access to a huge warehouse of IIMA case studies & research reports.[26]

2.4 REVIEW OF LITERATURE PERTAINING TO VARIOUS RECOMMENDATIONS FOR ICT INFRASTRUCTURE IN HIGHER EDUCATIONAL INSTITUTIONS:

In this section the researcher has strived to collect various proposals and suggestions various other researchers and other bodies have suggested for the minimum ICT facilities and standards that can be expected in an educational institution.

1) Nadir M., Emran M.H., Parvez M.M.,53 in their research paper titled Design and Implementation of a Secure Campus Network have suggested certain important points with regards to setting up a Network which spans the entire campus on an educational institution. According to their suggestions, it is important to install a firewall at appropriate place in the network to ensure
internal and external security of the network and the attached ICT facilities running on this network. Further, the authors have recommended the use of VPNs in case the Campus network is divided into branches. The authors have also advocated the use of VLANs for the purpose of network segmentation so as to increase the security over the network.

2) **Moberg T** in his paper titled Campus Network Strategies: A Small College Perspective has opined that network should be planned according to the strategic goals of the academic institution and should be used as a strategic asset which can make the institution better, stronger and run it efficiently and dynamically. It must be able to provide full access to information, enhance communication, Support for student services, coordinate the management activities and provide Administrative efficiency, library automation, telecommunications, Support for institutional advancement, help create relationships with external parties like alumni, parents, etc. through electronic mail and World Wide Web technologies.

Further the author’s suggestions w.r.t. ICT facilities have given under different dimensions. Of these under the Physical dimension the author suggests connectivity between on-campus and off-campus locations like teaching staff residences, etc. Under the Management dimension the author advocates having appropriate staffing, and budgeting along with security systems to control access to the ICT infrastructure.

Under Application dimensions the institution must make sure that the ICT provide facilities like access to knowledge through sources like Internet, library materials, print services, etc. Under Cultural dimension the ICT facilities must be able to connect students to campus life and teaching staff must be able to enhance the teaching and learning skills.

3) **I.T. services department of University of Colorado** while trying to suggest the minimum requirement or standard of ICT facilities has linked the same with the requirements or the purpose for which the facility is going to be used. According to them, the purpose of the computing facility has a great impact on design aspects including room layout, computer hardware, printing systems, projection/presentation systems, etc. How many computers, printers, etc. at
which located are needed greatly depend on the number of individuals and the purpose they want to use them for.

Computer hardware itself is greatly dependent upon the intended application and operating system that will be installed on such servers and PCs. They will greatly influence the CPU type, Memory capacity, Network devices, Audio, video, Monitor size, etc of the PCs and Servers. Another thing when it comes to providing ICT facilities is the financial budget available with the institution. Printing and scanning facilities according to the university depends on the department’s specific requirements for such facilities. Staff to install, configure, and maintain hardware and software. The bigger the size, complexity, and purpose of a computing facility the more will be the staff involved in its maintenance. Finally, The IT department has emphasized that there has to be an upgradation plan and budget for upgradation where university has proposed a three-year replacement cycle for hardware and a spending of about a third of original software costs each year in case of software.

To summaries, the researcher has found that not though other researches talk about an ideal network and ideal ICT facility, none has actually given exact specifications neither about the network or the ICT facility. Every thing has been left to the situation.

**SUMMARY:**

In this chapter, published articles, research studies, have been reviewed by the researcher. To some extent the review of literature has provided current scenery of management of information and communication technology infrastructure in higher educational institutions. Researcher has also reviewed some research papers, pertaining to security of information and communication technology security breaches of information etc.

The main aim of this chapter is to provide an overview of various researches regarding management of information and the communication technology infrastructure in higher educational institutions. It also endeavors to review briefly related literature to substantiate the reviews of experts. Researcher does not claim to review all the related literature in the context of this topic, selected for the study. It is just an attempt to take a glance at some significant study papers, or articles in the
context of information and communication technology, and its security specifically related to higher educational institutions.

These literature review focused on various aspects of ICT’s role in academics including higher education in India as well as internationally. It also focused on various aspects of ICT security including various types of security threats and their management.

What the researcher has perceived is that the focus of the research studies has been limited to following areas: introduction of ICT in academics, usage pattern of ICT, factors affecting successful implementation of innovative pedagogical practices using information technology, online education, technology-enabled active learning environments. Main thing to note here is that these studies are either theoretical or they are not from Indian context.

Researcher has recognized the following parameters which have been highlighted from literature review and further used for designing questionnaire and analysis wherever necessary.

**Table 2.1: Parameter Matrix**

<table>
<thead>
<tr>
<th>Norms followed for creating ICT infrastructure.</th>
<th>ICT implementation support source</th>
<th>Total number of Support Staff</th>
<th>Type of PCs and Servers</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Licensed Antivirus software available for PCs and Servers</td>
<td>Factors influencing increase in ICT security attacks / lapses</td>
<td>Factors which help reduce / prevent ICT security lapse or attack</td>
<td>Purpose of using institution’s ICT infrastructure</td>
</tr>
<tr>
<td>Percentage of Annual Budget is set aside for ICT and Actual expenditure Percentage made on New purchases / Up-gradation of ICT</td>
<td>Success factors influencing reduction / prevention of ICT security lapse.</td>
<td>Areas providing benefits and maximum Return on Investments on ICT.</td>
<td>Availability of Wi-Fi</td>
</tr>
<tr>
<td>Audit frequency</td>
<td>Maintenance of Internet usage logs</td>
<td>Drafted ICY policy in the institution and its display in the institution.</td>
<td></td>
</tr>
</tbody>
</table>

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To conclude, Researcher has observed that, there are very few study papers or articles available pertaining to security of information and communication technology system with reference to the educational institutions especially in Indian context. What work is available at present is more theoretical in nature instead of being empirical.

The research feels that empirical study needs to be conducted in Indian context. Real data needs to be collected from the field from appropriate respondents. Such Research must be targeted on study of factors like the current and potential uses of information and communication technology, satisfaction trends among academic users for various ICT infrastructure and services and identify the areas which need to be addressed to improve it. Other factors which need to be studied include ICT security issues and how they can be resolved. Management’s concerns regarding cost-benefit need to be understood too.
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