“A critical study of management and security of (ict) information communication technology in higher technical institutes in pune region”

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Submitted By

ABIRESH ABRAHAM

Under the Guidance of

Dr. Vilas D. Nandavadekar

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Declaration by the Candidate

I hereby declare that the thesis entitled **"A critical study of management and security of (ict) information communication technology in higher technical institutes in pune region"** completed and written by me has not previously formed the basis for the award of any Degree or other similar title upon me of this or any other University or examining body.

I further declare that the material obtained from other sources has been acknowledged in the thesis.

Place: Pune **ABIRESH ABRAHAM**

Date: **(Research Scholar)**

Certificate of the Guide

This is to certify that the thesis entitled **“A critical study of management and security of (ict) information communication technology in higher technical institutes in pune region”** which is being submitted herewith for the award of the **Degree of Philosophy (Ph.D.) in Management** of Tilak Maharashtra Vidyapeeth, Pune, is the result of original research work completed by **Mr. ABIRESH ABRAHAM**, under my supervision and guidance.

To the best of my knowledge and belief the work incorporated in this thesis has not formed the basis for the award of any Degree or similar title of this or any other University or examining body upon him.

Dr. Vilas Dattu Nandavadekar
(Research Guide)

Place: Pune
Date:

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(Research Scholar)

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ABBREVIATIONS

DTE	Directorate of Technical Education
ICT	Information and Communication Technology
IT	Information Technology
MCA	Master of Computer Application
MBA	Master of Business Administration
BE	Bachelor of Engineering
ME	Master of Engineering
B.Arch	Bachelor of Architecture
B.Pharma	Bachelor of Pharmaceuticals
PG	Post Graduate
UG	Under graduate
PC	Personal Computer
Wi-Fi	Wireless Fidelity
WLAN	Wireless LAN
LAN	Local Area Network
WAN	Wide Area Network
IEEE	Institute of Electrical and Electronics Engineers
IPS	Intrusion Prevention System
UTM	Unified Threat management
IDS	Intrusion Detection System
ERP	Enterprise Resource Planning
HEI	Higher Education Institute
IIM	Indian Institute of Management
IIT	Indian Institute of Technology

CHAPTER 1

INTRODUCTION

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1.0 INTRODUCTION

In current era, the modern man is ruled by machines. It really holds true today as our lives are, to a big extent, being controlled by machines. These machines though being man-made, can today think and take decisions of their own. These machines are called COMPUTERS.

Computers are everywhere. They are inside our cars, televisions, heart pacemakers, phones, etc. They are there is offices, homes, pockets and wallets. The penetration of computers is such that on internet people have shared their whole life's history. The term Computer is part of a much bigger but well managed system. This system is governed under the term Information Technology and even more commonly as Information and Communication Technology (I.C.T.).

I.C.T. is basically a technology or a group of technologies which manages Information. By the term Manage we mean create, store, index, retrieve and communicate (including exchange) data.

I.C.T. has integrated itself enterprise-wide. It impounds deep knowledge of the enterprise's business processes and manages the resources of an organization. It is a repository of information the organizational processes have generated on one hand, while on the other it provides timely and accurate data to enterprises to gain competitive advantages. Thus, I.C.T. provides cross-organizational information and data integration by using organization's embedded business processes which is very vital for all organizations including Higher Education imparting institutions.

In today's world, the I.C.T. setup has become an important foundation pillar of any institution including educational institutions. This is due to the fact that I.C.T. and its supporting tools and services firmly bind all departments and functions (horizontals as well as verticals) comprising an organization into a single composite unit.These I.C.T. services and tools support all functions on a higher education system like knowledge management, general administration and management, record keeping and academic operations. This gives the educational institution a more structured and professional look and more customer (student)centric. Apart from this, I.C.T. strives to decrease the running costs at organization level and catalyse the change process.

Higher Technical Education like engineering is a specialized education which needs more explanation of complex processes and phenomenon. Information Communication Technology (I.C.T.) has emerged to be a big player in this field. Online Library and Journal repositories can help students get to scholarly literature of national and International sources very easily. Internet-based Blogging and Video lectures available on free platforms like YouTube from faculty members of prestigious National and International institutions really help the students in their studies.

Moreover, using I.C.T. tools and infrastructure students (learners) as well as faculty members (the teaching staff) can get hold of knowledge resources as per their convenience and just-in-time. Another gift of I.C.T. is that it has been helpful in enriching curriculum.I.C.T. through online testing software provides structured objective type (Multiple Choice Question) testing possible which makes students mandatory to study the reference books to a more detailed level. Moreover, it saves assessment time, thus teaching staff can use it for other creative uses.

Universities in US and Europe have long back switched to the I.C.T. based learning systems, but in case of India, we find that it is still using the same old traditional teaching techniques. Because of this reason, the teacher's work timetable becomes tight. Many learners who work and still they want to upgrade their qualifications meet up with the problem of time mismatch. I.C.T. provide access to lectures, etc. to such students. Some of the prestigious institutes globally have come up with software which present and make available video lectures and PPTs to students. They also keep track of the time the learners have studied or viewed these study materials. At the end of each such tutorial the learner needs to submit an objective type assignment online before going to the next module. Marks are allotted to students based on their viewership of tutorials and online assignments. One such software has been developed by IIT Bombay (Powai) under Spoken Tutorials program. The Spoken Tutorials (http://spoken-tutorial.org/) by the Ministry of HRD (developed by IIT Bombay), under its National Mission on Education through I.C.T. are some of the highly appreciable works for spoken tutorials on free and open source software (FOSS) available in several Indian languages [14].

In order to enjoy the fruits of I.C.T., it is important that educational institutions should understand the very concept of I.C.T. and its functionality and attain the highest level of user satisfaction through its various tools and services. But while enjoying all the rewards of I.C.T., the educational institutions must also keep in mind the various threats posed towards them and their users which find their way through I.C.T.. Thus, the rewards of I.C.T. are accompanied with certain liabilities.

Be whatever, but the real success of I.C.T. can be considered only when the user of the I.C.T. (in our case the students and teaching staff) are satisfied with it. The users must show their involvement (and should be involved) at every stage of I.C.T. implementation, usage and upgradation and should give their valuable feedbacks so that improvements can be introduced. If users don't get what they expect, they will refrain from using the I.C.T. services. Thus, it is important that Institutions imparting Higher Technical Education make an effort of not only to take user feedback about general services and facilities but also take a detailed feedback on I.C.T. services these institutions are providing. As a matter of fact, there are very few such I.C.T. facilities-related feedbacks taken in India which specifically try to study the I.C.T. facilities in such educational institutions.

Another school of thought exists which believes that I.C.T. can't be used as a shortcut to good education. According to them, educational institutional that are underperforming or may be limited in resources, must focus almost exclusively on better teachers and stronger administrations. Technology strengthens the pedagogical capabilities of the higher educational institutes. Moreover, this group of intellectuals further thinks that investment in I.C.T. is unwarranted for most education systems and is futile. I.C.T.is good enough for wealthy and well-run institutions only [18].

In fact, whether I.C.T. is good for education is a very debatable issue but what we need to understand is "how I.C.T. can in fact be made to be useful foracademic fraternity?". This is further elaborated with the fact that there not too many imperial studies conducted which can really show the correlation between I.C.T. and Education [19].

In under-developed and developing countries like India we encounter many types of problems when trying to implement I.C.T. infrastructure. These include lack of basic infrastructure like structured electrical wiring, lack of regular supply of electricity, lack of telephony services (voice/Broadband/ISDN, etc.), and lack of wireless technologies like VSAT (which help in connecting remote areas) which makes things worse. These issues need to be addressed before planning I.C.T. implementation in schools and colleges.

Teaching & Non-teachingstaff members and students are supposed to be in the college or university premises for most of the working day i.e. nearly 8 hours a day. This means that they need computer network facility in schools and colleges which they can used for preparing lecture sessions, do assignments, write research papers, etc.

I.C.T. infrastructure installed in higher educational institutions have certain vulnerabilities and threats involved, which if exposed, can be catastrophic to the availability of network facilities for both staff and students and external parties. I.C.T. infrastructure and data security in higher education institutions is a great point of concern.

There are also issues regarding availability of adequate infrastructure in institutes of higher education.

The Institute’s Management’s Objectives, Strategies, policies, the decisions which the Management takes coupled with the thinking pattern of the management on various issues including financial decisions very much play an important role in the creation, maintenance, usage patterns, security, etc. of the I.C.T. infrastructure facilities and services.

ICT infrastructure and security is greatly influenced by Management decisions like how many machines to be purchased, configuration of these machines, internet bandwidth subscription, how many anti-virus to purchase, whether to install a firewall or not, what to allow to be downloaded by users, etc.

Computers, Servers, Firewall, Network cabling, antivirus, etc. are just the means to provide certain I.C.T. based services. They are just a part of the I.C.T. infrastructure. Where, what is installed and how it is going to be used is totally the Management’s decision. Thus, I.C.T. infrastructure itself can't be blamed for its own failure. Somewhere, Management decisions and policies are directly or indirectly involved.

This makes the study of various aspects I.C.T. including the basic setup, various services, network management etc. in higher educational institutions a vital area of research.

Thus, this research study endeavours to study I.C.T. setup available in institutions in an effort to identify the problems related the I.C.T.facilities availablein the Institutions imparting Higher Technical Education. It also endeavours to identify the gaps in the I.C.T.from the security and user satisfaction point of view and seeks to identify the areas where I.C.T. is providing benefits.

As a general observation it has been seen that I.C.T.facilities and services made available in higher technical educational institutes, including its security aspects,are not as per expectations of the end-users as well as statutory requirements in higher educational institutions. There is a need to address the gaps in in I.C.T. implementation, highlight problems in its security, recognize satisfaction patterns of its end-users, leading to identification of the problematic areas, implement remedial measures through change in management policies and strategies.

The study has clearly depicted that the I.C.T. facilities have found to give number of benefits for the academic fraternity as well as the society. Still the study has also revealed certain areas of academics and/or academic administration, etc. that are not performing as per expectations and are not giving appropriate ROI. There are also certain problems being faced because of certain policies of government as well as that of the management's. Nevertheless, it is the students and other stakeholders who certainly have issues pertaining I.C.T. facilities and their views can't be ignored as they are the ultimate consumers of I.C.T. facilities in the educational institution. Most of these problems have some connection with academic institution's management's policies. The researcher, therefore, has suggested various recommendations that would help the government take remedial actions so that students can get the best knowledge and other benefits by use of I.C.T. facilities available at their institutions of study. Creation of standardization in this areais really the need of the day.

1.1 EVOLUTION OF INFORMATION TECHNOLOGY (I.T.) AND I.C.T.

Information Technology started with something known as “Information” which is the heart of all core processes in the modern business world. But Information did exist in early civilizations too.

Paleolithic people began, at least 30,000 years ago, to store information by scratching and painting shapes on rocks. Later, came the Alphabets which were then used to create words which is the smallest element and carries a literal meaning.

When paper got invented by the Chinese, these drawings and alphabets were started to be drawn or written on paper.

As the information started growing the papers were bound into books. The only problem in book writing was that if a person wanted to search for particular information they had to go through the entire book which wasted a lot of time. In business scenarios where time is a limiting factor this elapse of time proved to be a loss in the competition filled market. So faster ways for computation and searching were invented in the form of computers in the 1900s. Later on databases were invented which could store huge amount of data and information.

But to get hold to these databases and computers, man needed communication between the computers. Thus, communication technology which included Telephone communication (analog) and digital communications became an integral part of this setup and, thus was born Information Technology.

In the beginning it was just I.T. It consisted of standalone computing devices. Later, by using integration of telecommunications technology like telephone lines and wireless signals, the communication and exchange of data between these computing devices was made possible. The word Communication was, thus, added to I.T. and it I.C.T. i.e. Information and Communication Technology.

Maria D. and Dimitri P. [20]state that I.C.T.includes a series of technologies which used are used to maintain the communication as well as information. Thus, I.C.T.comprises ofboth networks and applications running on the computing devices. According to them, the Networks component includes fixed, wireless and satellite telecommunications, broadcasting networks.

Thus, with the help of Information and Communication Technology theusers are able to access, store, communicate, as well as manipulate and operate upon the information.In fact, the main purpose of I.C.T. is to create greater access to information and communication in underserved populations.

1.2 CURRENT GLOBAL TRENDS IN USE OF COMPUTERS AND INTERNET

I.C.T. sector has shown phenomenon growth in the past decade globally and in India in particular. This is evident from the I.C.T. Development Index published United Nations International Telecommunication Union I.C.T. development Index is an index based on 11 indicators. As per 2013 report there are estimated 270crore people would have been using the Internet across the planet by end 2013[12][13].

The data depicted in Table 1.1 shows the use of computers and Internet in households and individual levels in different countries world-wide.

Table 1.1: Use of computers and Internet in households and individual levels in different countries world-wide(Source: ITU [16])

Sl No.	Country	Percentage of Households				Percentage of individuals			
		Com-puter	Year of data	Internet access at home	Year of data	Com-puter	Year of data	Internet	Year of data
1	Albania	...		13.7	2010	...		...	
2	Algeria	18.1	2009	10.0	2010	...		...	
3	Angola	...		5.7	2010	...		...	
4	Argentina	51.0	2011	47.5	2012	53.3	2010	54.1	2011
5	Armenia	28.7	2011	22.2	2011	...		...	
6	Australia	82.6	2011	82.7	2013	...		83.5	2013
7	Austria	80.9	2013	80.9	2013	82.0	2012	80.6	2013
8	Bahrain	92.7	2012	79.0	2012	78.3	2012	88.0	2012
9	Bangladesh	3.9	2011	2.8	2011	...		...	
10	Brazil	45.8	2012	39.6	2012	44.1	2010	48.6	2012
11	British Virgin Islands	...		...		...		...	
12	Bulgaria	54.9	2013	53.7	2013	52.9	2012	53.1	2013
13	Canada	84.1	2012	81.5	2012	...		83.0	2012
14	Chile	50.5	2011	40.9	2011	42.8	2009	52.2	2011
15	China	...		23.7	2010	...		...	
16	Colombia	42.2	2013	35.7	2013	51.7	2012	51.7	2013
17	Fiji	...		18.8	2010	...		...	

Sl No.	Country	Percentage of Households				Percentage of individuals			
		Computer	Year of data	Internet access at home	Year of data	Computer	Year of data	Internet	Year of data
18	Finland	88.7	2013	89.2	2013	90.9	2012	91.5	2013
19	France	81.6	2013	81.7	2013	79.7	2012	81.9	2013
20	Germany	88.9	2013	87.7	2013	83.9	2012	84.0	2013
21	Ghana	13.8	2012	11.0	2012	...		...	
22	Greece	59.5	2013	56.3	2013	55.5	2012	59.9	2013
23	Greenland	...		...		...		...	
24	Hong Kong, China	81.9	2013	79.9	2013	72.8	2012	74.2	2013
25	Hungary	73.1	2013	71.5	2013	71.8	2012	72.6	2013
26	Iceland	96.7	2013	96.4	2013	96.7	2012	96.5	2013
27	**India**	**9.5**	**2011**	**3.1**	**2011**	**...**		**...**	
28	Indonesia	15.6	2013	5.7	2013	...		14.3	2013
29	Iran (I.R.)	44.6	2013	35.8	2013	24.6	2010	31.4	2013
30	Iraq	...		...		...		...	
31	Ireland	83.6	2013	82.4	2013	77.1	2012	78.2	2013
32	Israel	78.2	2011	70.3	2011	73.6	2012	70.8	2012
33	Italy	71.1	2013	68.9	2013	56.0	2012	58.5	2013
34	Japan	75.8	2012	86.2	2012	67.4	2010	79.5	2012
35	Jersey	...		...		...		...	
36	Jordan	50.8	2011	35.4	2011	55.0	2009	26.0	2009
37	Kenya	3.6	2009	3.4	2009	9.1	2010	7.2	2010
38	Kiribati	...		...		...		...	
39	Korea (Rep.)	80.6	2013	98.1	2013	83.0	2012	84.8	2013
40	Lithuania	65.9	2013	64.7	2013	67.6	2012	68.5	2013
41	Luxembourg	94.3	2013	94.5	2013	92.6	2012	93.8	2013
42	Malaysia	65.1	2013	64.7	2013	...		...	
43	Mexico	35.8	2013	30.7	2013	43.4	2012	43.5	2013
44	Nepal	7.3	2011	3.3	2011	...		...	
45	Netherlands	95.2	2013	94.6	2013	93.4	2012	94.0	2013
46	New Zealand	78.0	2012	76.8	2013	82.6	2009	82.0	2012
47	Norway	93.3	2013	94.3	2013	95.0	2012	95.1	2013
48	Oman	82.9	2013	77.6	2013	...		66.4	2013
49	Pakistan	...		...		...		...	
50	Philippines	11.1	2009	10.1	2010	...		...	
51	Poland	74.7	2013	71.9	2013	63.8	2012	62.8	2013
52	Portugal	66.7	2013	62.3	2013	62.4	2012	62.1	2013
53	Puerto Rico	60.0	2012	49.0	2012	65.0	2010	69.0	2012

Sl No.	Country	Percentage of Households				Percentage of individuals			
		Com-puter	**Year of data**	**Internet access at home**	**Year of data**	**Com-puter**	**Year of data**	**Internet**	**Year of data**
54	Qatar	97.1	2013	96.4	2013	86.9	2012	97.6	2013
55	Russia	69.7	2013	67.2	2013	58.8	2010	61.4	2013
56	Rwanda	2.0	2011	...		...		...	
57	Singapore	85.0	2012	84.0	2012	69.7	2009	72.0	2012
58	South Africa	21.5	2011	33.9	2012	...		...	
59	Spain	73.4	2013	69.8	2013	72.2	2012	71.6	2013
60	Sri Lanka	...		5.9	2010	...		...	
61	St. Helena	...		...		...		...	
62	Sweden	91.9	2013	92.6	2013	93.2	2012	94.8	2013
63	Switzerland	83.7	2010	80.7	2010	...		85.0	2013
64	Syria	...		35.2	2010	...		...	
65	Thailand	29.1	2013	23.2	2013	33.7	2012	28.9	2013
66	Turkey	52.9	2013	49.1	2013	45.8	2012	46.2	2013
67	United Arab Emirates	85.2	2012	72.0	2012	84.2	2012	85.0	2012
68	United Kingdom	88.2	2013	88.4	2013	88.5	2012	89.8	2013
69	United States	75.6	2011	71.7	2011	...		69.7	2011
70	Venezuela	37.8	2012	28.6	2012	...		49.1	2012

Table 1.2: Chart showing the Number of Individuals using Internet (in Millions) region-wise (Source-ITU [17])

	Year									
Country	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014***
Africa	17	24	29	45	58	79	105	125	148	172
Arab States	26	36	44	55	66	81	94	121	137	152
Asia & Pacific	**344**	**394**	**503**	**615**	**726**	**872**	**988**	**1,113**	**1,205**	**1,310**
CIS	29	35	47	55	67	95	115	128	143	158
Europe	277	300	340	368	388	410	428	443	456	467
The Americas	316	346	385	405	428	473	519	556	597	639

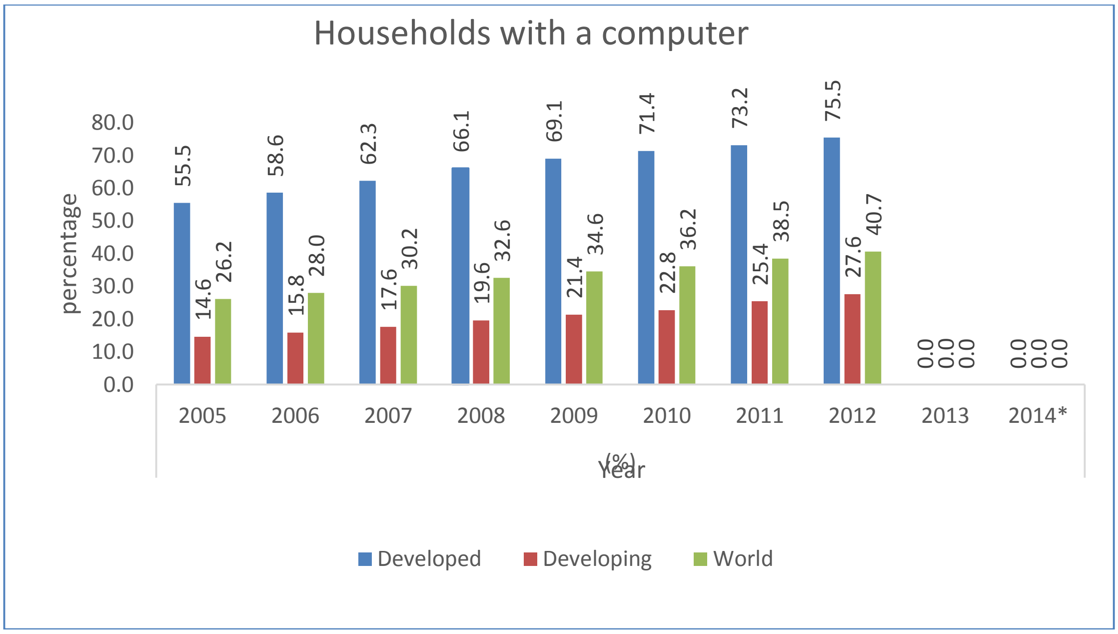
Table 1.2 clearly shows that the highest number of Individuals using Internet in the year 2014 are fromAsia and Pacific region. As India is a part of Asia, this is a very convincing figure.

From economic development point of, the countries, as we know, can be categorized into developed, Developing countries. Looking at the trends of I.C.T. penetration in households from economic development point of view of a country,Table 1.3demonstratesthat in developed countries the increase in household computers has increased from 55.5% in 2005 to 75.5% in 2012, an increase of 20%. On the other hand, in case of developing countries the increase for same period is 13% which is just 7% less than that of developing countries. This indicates that the trends of I.C.T. global presence trends is improving by the year [17]. [Refer Table 1.3 & Graph 1.1]

Table 1.3: Percentage of Household Computers (source ITU[17])

Country Type	(% of Household Computers)									
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014***
Developed	55.5	58.6	62.3	66.1	69.1	71.4	73.2	75.5	N/A	N/A
Developing	14.6	15.8	17.6	19.6	21.4	22.8	25.4	27.6	N/A	N/A
World	26.2	28.0	30.2	32.6	34.6	36.2	38.5	40.7	N/A	N/A

Graph 1.1: Percentage of Household computers(source ITU)



1.3 COMPONENTS OF I.C.T.

Different people have described the Components of I.C.T. in different ways. In this section we will take a look at the various ways.

Stephen Doyle [32]divided I.C.T.into following 6 components namely:

a. Data:

These are raw facts and figures which really don't carry any meaning and are generally in un-tabulated and un-coded form. The source of such data could include a transaction, survey, etc. or an output of another I.C.T. system.

b. Hardware Component:

These are the physical components and include Input devices (such as keyboard, mouse, etc.), The CPU (processor), The Storage and Backup devices (hard disk, etc.) and, finally the Communication device (NIC cards, Switches, routers, modems, etc.).

c. Software:

These are the computer programs running of the system. Oxford Dictionary defines it as "The programs and other operating information used by a computer".[28]

These include System Software like Operating System andApplication Software like Database, file processing software, and Firmware e.g. device drivers

d. Information:

This is processed data that is transformed to give it a meaning.A good example of this is the gender wise list of students who are weak in English.

e. Procedures:

Procedures are a series of activities conducted in a certain order to make certain thatthe system runs smoothly. They help in processing the raw data into meaningful information and reports.

f. People:

Input of Data is carried out by humans using devices like keyboard, mouse, etc. They are the ultimate source and consumers of data and information.

Saleem and Shabana in their research paper had quoted Rahman L.M. addressing I.C.T. asa fusion of two important technologies viz. Electronics & Communications. [31]

Further Patil, Kumbarand and Krishananda added 2 new terms to this group namely Communication Technology and Reprographic, micrographic and printing technology. Of these, Communication Technology, which includes the network devices, helps data to be exchanged between the hardware for example between computers, etc. using electronic, wireless or light (fiber-optic) media.

Reprographic, micrographic and printing technology one the other hand are used to make photocopy and digital copies of documents, thus, helping in preservation of documents. Examples of these typewriters photocopy machines [29].

1.4 IMPORTANCE OF HIGHER EDUCATION: A GLOBAL PROSPECT

Our lives are heavily dependent on technology. As science and technology is advancing, higher level of education and knowledge (especially technical) is needed by the society as society is dependent on technology. This is necessary as all people want better jobs and better earning.

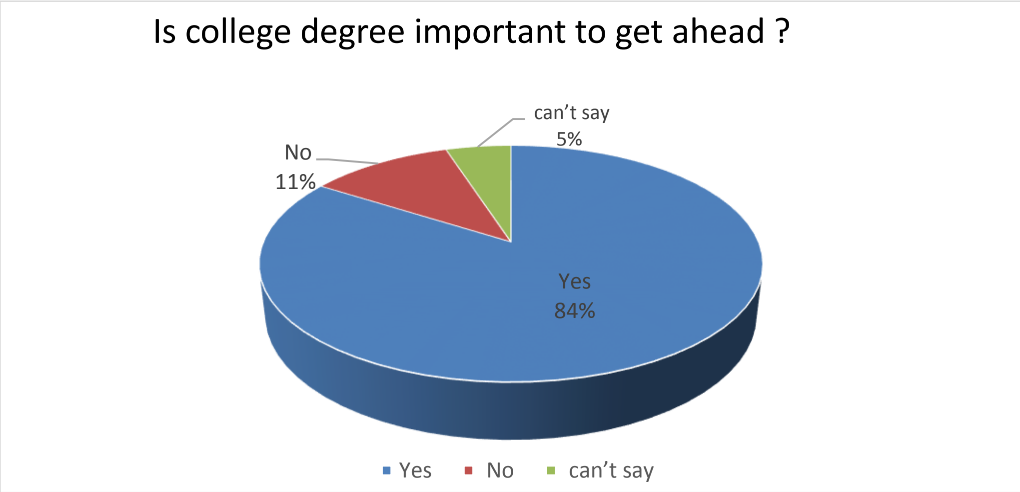
Findings from the study titled *The Affordability of Higher Education: A Review of Recent Survey Research*, points out that American citizens are of the opinion that college education overtaken high school education, and has become an essential constituent for a worthy job and comfortable lifestyle. This is evident from the data presented in Table 1.4 and Graph 1.2which depicts whether respondents think college education is important to get ahead.

Table 1.4: Is college degree important to get ahead [15]

Is college degree important to get ahead

Response Type	Response Percentage
Yes	84%
No	11%
Can’t say	05%

Graph 1.2: Pie chart depicting the responses w.r.t. "Is college degree important to go ahead?"



Further, Immerwah's findings further point out that nearly 66% of those who didn't attend college wished that they had, and 62% of people felt that having gone to college would have made a substantial difference in their current standard of living [15].

These findings confirm that higher education's importance has been understood by people specially those belonging to developed countries.Another role of higher education is to transfer sophisticated knowledge to the next generation. Higher education generally focuses on skill building. As Skilled and specialized jobs are performed by highly skilled professionals, thus, these professionals need to transfer their skills and knowledge to the next generation. Like parents pass on their life experiences and characteristics to their children through their DNA, same way knowledge needs to be passed from experts (professionals and/or teachers) to students, from generation to generation for retention and further development of knowledge.

Other important reasons for going in for higher education that are noteworthy and un-ignorable include points like Students Learn How to Solve Problems and Learn How to Deal with Other People. Also, Higher education skills helps students find a lucrative career while teaching you how to deal with a variety of other real-life situations.

1.5 GLOBAL HIGHER EDUCATION TRENDS

Higher education is a global phenomenon. Universities on a global scale are completing for their share of students in this sector. Here, the researcher presents a few cases which can through light on the contemporary trends in higher education.

Report published by Oxford University[27], based on inputs from the OECD, UNESCO, the US Institute of International Education and the UK Higher Education International Unit, the British Council, highlights developments in international higher education. Their report is more inclined towards students going for higher education abroad. Their reason for this is based on the fact that recruiters want new employees whose skills include openness to new challenges, problem-solving and decision-making – all skills and these skills can be cultivated in students that living and studying in a new country It states the example of USA which has launched a programme titled ‘Generation Study Abroad’, which strives to provide international experience to students during their degree and helps increase student admissions. The report also tells about certain well-known universities establishing their international campuses in places like Dubai, Pakistan and China to increase international student intake under their facet of institutional international strategies. Many such universities have created international campuses in partnership with universities belonging to host countries.

Massive Open Online Courses (MOOCs) being conducted by reputed universities like Stanford is rapidly becoming popular. This is a great example of Technology in teaching with more than 142 universities taking up such initiatives.

Trends also show that students from parts of Africa are fast moving towards South Africa, UK, France and other European countries for higher education.

Published by British Council [4], report on global higher education provides an in-depth analysis of contemporary trends that have shaped higher education worldwide. It highlights relation of demographic and economic drivers on the changing higher education scenario emerging economies. It found that emerging economies are becoming increasingly popular study destinations and have shown significant growth in the area of research and internationally filed patents. Another trend predicted is that by the year 2020, China (585,000), India (296,000) and South Korea (134,000) could be the principal countries of origin for international students.Also countries like

Malaysia, Singapore, Chinaand some Gulf States could become the fastest growing study destinations replacing Europe, Australia, etc. in the near future.

Table 1.5 depicts some of these estimated international trends in higher education and Research.

Table 1.5:Global Higher Education and Research Trends by 2020 (British Council[4])

Trend Description (by year 2020)	Country	Estimated number of students
Prime outbound mobile student flows (by origin)	China	5,85, 000
	India (296k),	2,96, 000
	South Korea	1,34,000
	Nigeria	67,000
Largest inbound mobile student flows by destination	USA	5,82,000
	U.K.	3,31,000
	Australia	2,77,000
	China and Malaysia	Forecasted to make entry here
Largest growth in research output	US and Chinese	Not available
Highest Research collaboration rates: Research	smaller countries like Switzerland and Belgium	50 to 70%

1.6 HIGHER EDUCATION: AN INSTRUMENT FOR NATION BUILDING

The impact of an education on economic growth is well documented.

India is the birth place of education. ‘0’ and decimal were invented here. India is the homeland of Nalanda University, the first formally documented University of the World. Thus, higher education was invented here in India.

India’s first Prime Minister Late Pt. Jawaharlal Nehru looked at University as a place for REASON and for the ADVENTURE of ideas. Dr. S. Radhakrishan thought that values of justice, democracy, liberty, fraternity and equality greatly depends on high standard of general, professional and vocational education.According to him, The

Indian Universities must strive to educate people on the right lines to make the understanding and vision of the framers of the constitution.

The NATIONAL POLICY ON EDUCATION(1986) provides the citizens of the country with achance to reflect on critical social, cultural, moral, economic, and spiritual issues facing the humankind. It specifically aimed at national development through propagation of specialized knowledge & skills and while doing so preserving the rich heritage of the country.

The amended NATIONAL POLICY ON EDUCATION (1992) regards Education as an evolutionary force that aims at enabling superior spiritual, ethical, aesthetical and intellectual powers. Education aims at developing a new type of humanity which is much more highly humane, cultured and integrated. Education is a powerful carrier of the traditions, culture &heritage and. It carries forward to the new generations the lessons learnt from accumulated experiences of the past. This will helps in present day and future progress. It regards Universities to be at the pivot of the educational hierarchy and that they play a strategic role in producing educators for the teaching system at all levels [21].

The Economic Benefit *of Increased Participation in Education and Training in Australia*[1] concludes that by increasing the participation rate in higher education has shown significant increase in national productivity and wage rates. This has also lead to an increase in people getting better paid jobs. This can be justified by the fact that in Australia within one generation GDP has increased by 1.1% when participation of students in education was increased by about ten percent. Thus, a sign of prosperity of the country.

The study further concludes that Increased investment in the education and training benefit by increasing the number of future workers. It increases their knowledge and skill levels. This contributes in increasing national productivity. It also helps Australians in helping sustain themselves for a lifetime. An educated skilled worker can find new job opportunities much quickly and easily than an ordinary worker. This decreases unemployment rates and saves government expenditures on welfare schemes for unemployed population.

Availability of skilled labour in Australia itself has decreased its dependency on migrated labour from other countries thus again reducing the burden on its tax payers to support bigger populations.[1].

To summarize, higher education helps in transfer of knowledge and heritage from generation to generation, build on the ethics of democracy and values bestowed by constitution of the country. It helps in generating skilled workers, help in increasing their earnings. Thus, it increases GDP of a country and reduces budgetary burdens on government of the nation.

1.7 HIGHER EDUCATION TRENDS IN INDIAN CONTEXT

The face of higher education in Indian context has greatly changed since Independence of the country. This section discusses some of the important trends in education, higher education including number of institutions, number of enrolments and budgetary expenditure of central and State governments on education.

MHRD records[25] show that number of universities and University - level Institutions has depicted a phenomenal 15-fold increase since independence till 2007. Further, the number of colleges has increased 40-folds during the same duration. These facts are shown in Table 1.6.

Table 1.6:Higher Education trends in India 1950 to 2007

Year	No. of Universities and University level Institutions	Number of Colleges	Total Enrolments in Higher Education (in Millions)
1950	27	578	0.40
2007	406	23,099	17.21

(Source: MHRD (GOI)[25])

Looking at the budgetary expenditure on education by both central and State / Union territory governments[24] (Refer Table 1.7),it is evident that every financial year the budget on Education is seeing an increase. Here, we must emphasize on the fact that education budget was hardly able to touch the 13% mark.

Table 1.7:Budgetary expenditure on Education

Financial Year	Actual / Budgeted Expenditure on Education (INR Crores)	Percentage of total Budgetary expenses in all Sectors
2004-2005	81,280.85	10.19%
2005-2006	97,224.19	10.61%
2006-2007	1,32,749.28	13.03%

(Source: MHRD (GOI)

If we look closely on the division of education expenditure in financial year 2006-07 [24], we find that the highest amount was spent on *Elementary education* (53.1%) where much less amount was spent on *University and Higher education* (10.88%) and technical education (3.72%).[26]

Table 1.8: Statement indicating the Public Expenditure on Education

Financial Year	Spending on Education by Education &Other Departments (Rs. in crore)	Spending on Education by Education &Other Departments (Percentage of Public Spending)	Percentage change
1951-52	64.46	7.92%	--
1960-61	239.56	11.99%	+4.07
1970-71	892.36	10.16%	-1.83
1980-81	3884.20	10.67%	+0.51
1990-91	19615.85	13.37%	+2.27
2000-01	82486.48	14.42%	+1.05
2008-09	154409.85	13.63%	-0.79

(Source: MHRD (GOI [26])

Table 1.8, illustrates the trends in education funding by government of India (28). Figures show that since independence the maximum budgetary expenditure in this sector was seen in the year 2000-2001 (14.42%) which is too low for a country having the 2ndhighest population in the world.

Ernst and Young and FICCIsummit report states that the Indian higher education system has come up as one of the largest in the world, with 14.6 million students who have enrolled in nearly 31,000 colleges, universities, institutes, etc. [8].

The no. of universities in India has increased at a CAGR (Compound Annual Growth Rate) of 7.5% (an increase of 284 universities).Similarly, the no. of colleges has increased at a rate of 11% (from approx. 11000 to approx. 31000).

Talking about the trends of student enrolment, report published by Ernst and Young and FICCI states that while only 2 million students were registered for higher education in 1970-71 this figure has grown nearly 12 times in last 4 decades to 25.9 million in 2011-2012 [8].

Some of the efforts taken by Government of India and state governments to enhance the higher education sector in the country includethe passage of various bills and laws. These include: Foreign Educational Institutions Bill, 2010, Prohibition of Unfair Practices in Technical, Medical Educational Institutions and Universities Bill, 2010, The National Council for Higher Education and Research Bill, 2010,The National Accreditation Regulatory Authority for Higher Educational Institutions Bill, 2010, , and The Educational Tribunal Bill, 2010 to name a few. States like Maharashtra have The Maharashtra Unaided Private Professional Education Institutions (Regulation of Admissions and Fees) bill, 2015.

Various Apex bodies have been established to monitor and manage higher education and research in India and fall under the Ministry of HRD, Government of India. Table 1.9 shows a list of these various bodies and their role:

Table 1.9: Apex Education Bodies under MHRD (GOI)

Sl. No.	Name of the Organization	Purpose and Functionality
1	A.I.C.T.E.	a) Promotingthe Quality of Technical Education. b) Planned & Co-ordinated growth of Technical Education System. c) Regulations and maintenance of Norms and Standards.
2	Council of Architecture (COA)	a) Architect Registration b) Standardization of education, c) Recognize qualifications d) Recognize standards of practice by the practicing architects throughout India. e) Maintain the register of architects.
3	I.C.H.R.	a) Provide a platform for exchange of views between historians. b) Provide direction to an objective and scientific writing of history c) Rationalizepresentation & interpretation of history. d) Promote & coordinate balanced research work in history. e) Provides fellowships f) Provide financial assistance to the Researchers.
4	I.C.P.R.	a) Strengthen philosophical research and studies in India b) Periodic review, promotion, financial support and sponsorship of research in philosophy. c) Promote international collaboration in research.

		d) Promote teaching in philosophy.
5	I.C.S.S.R.	a) Promote research in social sciences. b) Review the progress of social science research. c) Sponsorship, financial support and scholarship for social science research projects and for interdisciplinary research. d) Identify neglected or new areas of research; e) Arrange for technical training in research methodology by Organizing, sponsoring, and financing seminars, workshops and study groups. f) Undertake publication of journals, etc. in social sciences;
6	U.G.C.	a) Providing funds and b) Determine, Co-ordinate, and maintain minimum education standards in institutions of higher education.

The UGC (University Grants Commission), established by the UGC Act 1956, has been given the two tasks of: a.) Providing financial support and b.) Standardization, Co-ordination, and maintenance of minimum standards of education in institutions of higher education in India. Table 1.10 summarizes the list of universities and colleges in India (only approved by appropriate regulatory authorities)[22][36] [37][38][39].

Table 1.10: List of different institutions compiled from UGC and MHRD (GoI) Records

Type of Institution	No.	Remark
Autonomous colleges under UGC Scheme	*374	Tamil Nadu ranks at No. 1 followed by Andhra Pradesh
Deemed-to-be Universities established under section 12(B) of the U.G.C. Act	127	as per MHRD data 2013-14
**State Universities	347	As on 1th January, 2016
***Private Universities	228	As on 14th January, 2016
**** Central Universities	46	As on 15th January, 2016
# Institutions of National Importance	74	
IIMs	19	
IISc. Bangalore and IISERs	06	
IITs	16	
IIITs	24	
NITs	30	

Table 1.11 displays a Comparison of Enrolment in Higher Education in 2013-14 and 2014-15 [3]as per India Survey on Higher Education (AISHE), MHRD (GOI).

As per records shown in Table 1.11, the researcher concludes that maximum enrolment at Under Graduate levelis on an average is at 79%for both academic years and shows a slight rise of 0.43%. The bad news is that at Post Graduate level shows a sharp decline when compared to Under Graduate enrolments for both years. This shows a decline in percentage highly skilled workman population.

Percentage Enrolments in Ph.D.are still drastically low as compared to Post Graduate level Enrolments which depicts that India is lacking in research scenario.The situation has hardly changed in these 2 academic years.

Table 1.11: Comparison of Student Enrolment in Higher Education in 2013-14 and 2014-15 as per India Survey on Higher Education (AISHE), MHRD (GOI)

Level	Total Enrolments (2013-14)	Enrolment Percentage (2013-14)	Total Enrolment (2015-16)	Enrolment Percentage 2015-16
Ph.D.	84000	0.28	112812	0.34
M.Phil.	35000	0.12	32371	0.10
Post Graduate	3374000	11.39	3809322	11.45
Under Graduate	23538000	79.44	26576140	79.87
PG Diploma	215000	0.73	186548	0.56
Diploma	2124000	7.17	2247430	6.75
Certificate	176000	0.59	175907	0.53
Integrated	83000	0.28	132192	0.40
Total	**29629000**	**100.00**	**33272722**	**100.00**

The Table 1.12 shows a comparative analysis based on Percentage of student enrolments in Ph.D., Post Graduate and Under Graduate levels for higher education as collected and presented by India Survey on Higher Education (AISHE), under Ministry of HRD(GOI). It depicts that at Under Graduate level, it is Social Science (40%), Engineering & Technology (16.34%), and Commerce(14.53%) that lead the way in enrolment percentage. Management and IT and Medical Sciences are way behind. [10]

At Post Graduate level it is again Social Science (20.58%) that leads the way in enrolments, followed by Management (16.92%) and IT(9.34). These official figures make us conclude that Social Sciences are favorite among students at both Under Graduate and Post Graduate levels. The second fact that is that Students who have done Engineering and Technology either do not in for Post-Graduation or shift towards other more lucrative careers like *IT* and *Computer or Management* for better career prospects.

Table 1.12: Percentage Enrolment in different disciplines at Post Graduate and Ph.D. level (2013-14) as per India Survey on Higher Education (AISHE)

Discipline	Enrolment Percentage (Year 2013-14)		
	Ph.D. (%)	**Post-Graduate (%)**	**Under Graduate Level (%)**
Agriculture	4.39	.61	.55
Commerce	3.21	8.04	**14.53**
IT and Computer	1.93	**9.34**	4.11
Engineering and Technology	**17.45**	6.34	**16.34**
Foreign Lang.	3.16	4.83	--
Home Science	.68	.21	
Indian Language	6.14	8.78	.46
Law	.84	.76	.95
Management	4.47	**16.92**	2.91
Medical Science	6.50	4.17	2.87
Science	**20.61**	8.75	12.60
Social Science	**18.27**	**20.58**	**40.69**
Education	--	--	3.10
Others	12.35	10.69	1.60

To summarize, the research concludes that though the government of India and state Governments are doing a lot by establishing new universities, colleges, institutions of national importance, etc. students are not going in for Post-graduates after Under-

Graduate studies. Government is spending a lot on defence and sectors but expenditure on education has never crossed the 15% point.

1.8 I.C.T. IN HIGHER EDUCATION INSTITUTIONS: NEED AND USAGE PATTERN

I.C.T. or Information Communication Technology has become an indispensable part of our everyday life. Education has also not been left untouched.

India is a country which has abundance of un-nurtured talent. Absence of timely and easily available knowledge and information assets to all has time and again indicated that we have lost so many opportunities in becoming world super-power and biggest source of skilled workmen. There has been a lack of collaborated learning and the excellence in teaching at various places is highly questionable. This can be solved through implementation of I.C.T..

As we have discussed in earlier sections, many institutions like IIMs, IIScs, and IITs have been established to generate skilled workmen. But there exist problems for students to get to these institutions. Firstly, the competition is very tough. Secondly, the high fee charged by these institutions can't be afforded by all. Thirdly, at current rate of population explosion in the country, we cannot hope to quickly make a dent on the base line educational status of the population. Thus, lots of talented students fail to make to these institutions. Through Online courses in distance education mode, such people can get an opportunity to get skilled.

Higher education is a specialized education which needs more explanation of complex processes and phenomenon. I.C.T. provides audio-video explanation for such things.

Online Library and Journal repositories can help students get to scholarly literature of national and International sources very easily. Blogging and Video lectures available on free platforms like YouTube from faculty members of prestigious National and International institutions really help the students in their studies. Thus, I.C.T. when used in conjunction with conventional approach can make available the knowledge resources to every learner as per his / her convenience and just-in-time. Internet has made this a reality today.

It has also been found that I.C.T. has been helpful in enriching curriculum. Further, computer assisted instructions provides a flexibility in the curriculum.

In India, we are still using the old fashioned examination system where we use descriptive questions to test our student's progress. Such non-standardized testing poses a lot of problem. Later, we find that these students are unable get the certification needed for prescribed requirements for the job and unable to answer Objective type selection tests used for jobs by MNCs as generally students just study a limited set of questions for preparing for exams. Universities in US and Europe have long back switched to objective type testing which makes students mandatory to study the reference books to a more detailed level. I.C.T. can help in customized observation and long term tracking of growth and improvement in learning, skill-development and performance. Online line exam software can help in the assessment work with least burden on the faculty members bestowed with the work of assessment.

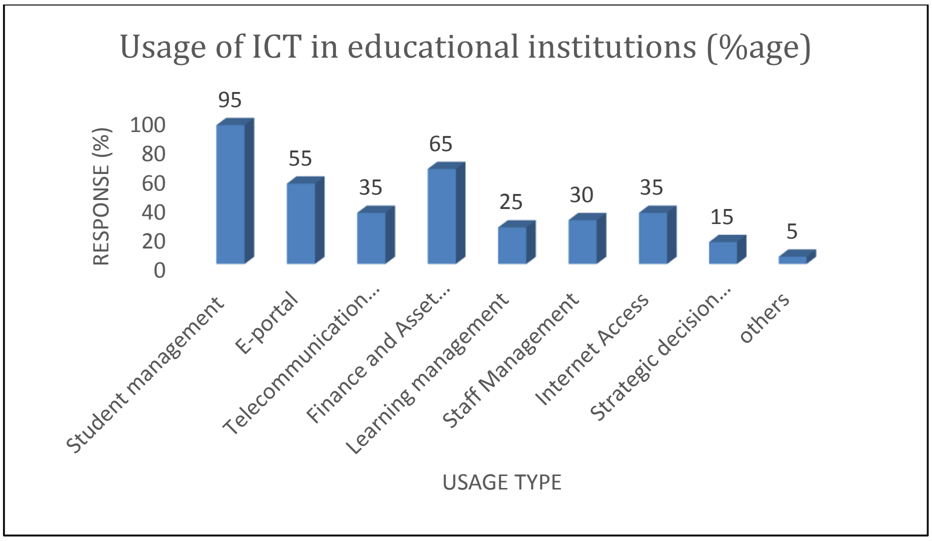
There is also a case of learners who work and still they want to upgrade their qualifications. But then there are learners who want to study as well as they need to earn their livelihood. Due to time mismatch between college hours &Job hours such people are not able to upgrade themselves. I.C.T. provide access to lectures, etc. to such students. Some of the prestigious institutes globally have come up with software which present the video lectures and PPTs to students. They also keep track of the time the learners have studied or viewed these study materials. At the end of each such tutorial the learner needs to submit an objective type assignment online before going to the next module. Marks are allotted to students based on their viewership of tutorials and online assignments. One such software has been developed by IIT Bombay (Powai) under Spoken Tutorials program. The Spoken Tutorials (http://spoken-tutorial.org/) by the Ministry of HRD (developed by IIT Bombay), under its National Mission on Education through I.C.T. are some of the highly appreciable works for spoken tutorials onfree and open source software (FOSS) available in several Indian languages [14].

Soria A. S., Onashoga S. A. and Rosanwo, O. D. in their research work titled "Managing I.C.T. Infrastructure in Higher Educational Institutions", concluded that higher education institutes in Nigeria (Africa)useI.C.T. at these institutions (Refer Table 1.13). They reached this conclusion from responses from 15 higher institutes in Nigeria which is an under-developed country.[33]

Table 1.13: Usage pattern of I.C.T. in higher educational institutes in Nigeria [33]

Usage types	Usage Percentage
a) Student management	95
b) E-portal	55
c) Telecommunication Services	35
d) Finance and Asset Management	65
e) Learning management	25
f) Staff Management	30
g) Internet Access	35
h) Strategic decision making	15
i) Others	5

Graph 1.3: Usage pattern of I.C.T. in higher educational institutes in Nigeria



1.9 CHALLENGES TO INTRODUCTION OF I.C.T. IN HIGHER EDUCATION

Though I.C.T. has been found to be useful but research and observation have proved it is not easy to implement it.

Devex discusses about such challenges. It states that there is a lack of collaboration between Technology companies, private sector organizations, Universities, and government including central, state and local one. Lack of operating knowledge, expertise, or organizational capacity also makes it to the list. Organizational structures, strategies and culture, staffing problems are the next in line of such challenges. Lack of funding and gaps in income structure of the population deeply impact the pace of introduction and upgradation of I.C.T. facilities [7].

Research work titled "New Technologies for Teaching and Learning: Challenges For Higher Learning Institutions in Developing Countries" have pointed out to some of the challenges related to integrating I.C.T.technologies in higher educational institutions[6]. (Refer Table 1.14)

Table 1.14: I.C.T. Services and challenges in their implementation [6]

Service	**Challenges**
TV/ radio	• Simplex communication. • Costly in TV production video graphics are costly to make. • Costly hardware, Licensing for broadcast from government needed. • Access to TV / radio Broadcasters network expensive.
Web-based Technologies	• Specialized programmer, author and graphic artist needed. • High internet speed at both transmitting and receiving end. • Fast computers with sound cards • High performance Hardware for servers needed along with technical experts. • Internet connection needed by both content deliverers and users which is costly.
Video Conferencing	• High internet speed at both transmitting and receiving end • Needs Sound proof area • Lightingneeds to be maintained. • Needs Audio-videodeviceslikeDisplay monitor or projector, video camera, microphone(s), along with Video-conferencing equipment • High bandwidth • High costs.
e-learning platforms	• Constantly adding and changing content necessary. • Server hardware as well as Client hardware needed • Organization/ registration/ administration • Quality learning content in standard formats needed

In under-developed countries there are many old school and college buildings. Further unstructured electrical wiring, lack of regular supply of electricity, lack of telephony services (voice/Broadband/ISDN, etc.), and lack of wireless technologies like VSAT (which help in connecting remote areas) make things worse. These things need to be addressed before planning I.C.T. implementation in schools and colleges [40].

Gichoya observed that in Kenya the problem with I.C.T. implementations is that most such I.C.T. projects donor funded. Moreover, such assistances are made without prior discussion or carrying out a requirement analysis by the recipient organization. The Operational/running costs are generally met by the government funds but human resource requirements are not met. As costs go up every year the budgets for I.C.T. are always inadequate. Mostly there are no master plans to guide investments in I.C.T.. When it comes to donors, it happens that the number of donors becomes multiple who keep funding same project multiple times do to lack of co-ordination. The I.C.T. resources are also unstable [9].

The findings of Hadi Salehi and Zeinab Salehi indicate that Teachers want to use I.C.T. in the classroom, but some blockades like inadequate technical supports at schools, lack of Internet access restrict incorporation of I.C.T. into the curriculum. Shortage of class time also discouraged teachers to use I.C.T. in the classroom[11].

A section of research scholars and school of thoughts have gone to the extent of categorizing the I.C.T. implementation barrier into 2 categories namely a.)Teacher-level barriers, and b.) School-related (institute-related) barriers. Of these Teacher level barriers are more of Individual level problems. British Educational Communications and Technology Agency (BECTA) defines such individual teacher-level barriers as teacher's lack of of self-confidence, lack of confidence in the Technology, shortage of time for preparation or delivery, and individual's resistance to accept change. School-level barriers include lack in providing training w.r.t. solving technical problems &absence of access rights to resources [5].

Need of the hour is to understand that I.C.T. use in education should follow use in society, not lead it.

1.10 RESEARCH ISSUES

India is fast emerging as the educational hub of the world. Government of India is trying its level best to put India's education system on the world platform. To become a world player in education sector we not only need to teach nicely but need to inculcate knowledge which is in addition to the book knowledge. For this we also need to have world-class infrastructure. This infrastructure not only includes desks and tables in classes and lavish office furniture and good gardens outside the colleges, but we also need study material and a gateway to endless literature and knowledge on various subjects which can be used for teaching purpose and research purpose. Gone are the days when one had to buy numerous books and sit in library for hours. This has happened with the advent of internet.

Faculty members and students are supposed to be in the college or university premises for most of the working day i.e. nearly 8 hours a day. This means that they need computer network facility in schools and colleges which they can use for preparing lecture sessions, do assignments, write research papers, etc.

I.C.T. infrastructure installed in Institutions imparting Higher Technical Education have certain vulnerabilities and threats involved, which if exposed, can be catastrophic to the availability of network facilities for both staff and students and external parties. I.C.T. infrastructure and data security in higher education institutions is a great point of concern.

There are also issue regarding availability of adequate infrastructure in Institutions imparting Higher Technical Education.

Moreover, Computers, Servers, Firewall, Network cabling, antivirus, etc. are just the means to provide certain I.C.T. based services. They are just a part of the I.C.T. infrastructure. Where, What is installed and How it is going to be used is totally the Management’s decision. Thus, I.C.T. infrastructure itself can’t be blamed for its own failure. Somewhere, Management decisions and policies are directly or indirectly involved.

This makes the study of Management of various aspects I.C.T. facilities and services in higher educational institutions a vital area of research.

As a general observation it has been seen that I.C.T. infrastructure including its security is not as per expectations of the end-users as well as statutory requirements in higher educational institutions. There is a need to address the gaps in in I.C.T. implementation, highlight problems in its security, recognize satisfaction patterns of its end-users, leading to identification of the problematic areas, implement remedial measures through change in management policies and strategies.

Thus, this research study endeavours to identify the problems related to the I.C.T. infrastructure facilities made available by the Institutions imparting Higher Technical Education. It also endeavours to identify the gaps in the I.C.T. facilities provided by Institutions imparting Higher Technical Education by looking at the satisfaction levels for some of the common I.C.T. services offered such institutions. Furthermore, this research study takes a look into the prevalent security issues faced with regards toI.C.T. infrastructure and digital data assets, thus, identifying security gaps and proposing remedies in order to envisaged results. Lastly, the study also tries to enlist the various economic and strategic benefits which higher technical education institutions can achieve by implementation of I.C.T. infrastructure and its various services.

As a final output of this research study the research scholar also suggests a theoretical model framework for creating an efficient I.C.T. infrastructure facility which can provide efficient and economical data security and greater user satisfaction, thus, leading to accomplishment of envisaged results.

1.11 RESEARCH BACKGROUND AND MOTIVATION

The Right to Education Act (RTE), enacted on 4 August 2009 calls for education as a right for all children under Article 21A of the Indian Constitution. But education only till school level is not enough for the country to become a superpower.

Information and Communications Technology (I.C.T.) is often used as an extension for Information Technology (I.T.). The computer is the nearest thing we have to a universal tool.

Implementing I.C.T. in educational institutions especially at university and other higher education levels is actually the beginning rather than the end of the story. There are rather a lot of controversies involved with I.C.T. implementation viz. quality and quality of I.C.T. infrastructure & services provided by a particular Higher educational institution, and security of data (individual and institutional) from external and internal threats. Important to mention here, is another big concern and that is the satisfaction in the minds of users of this infrastructure and its related facilities. Management of such institutions have their own agenda and that is the benefits it wants to get by implementation of the I.C.T. infrastructure. This all makes the scenario even more debatable and critical to the success of I.C.T. infrastructure in that particular institution.

As a general observation it has been seen that I.C.T. infrastructure including its security is not as per expectations of the end-users as well as statutory requirements in higher educational institutions. There is a need to address the gaps in I.C.T. implementation, highlight problems in its security, recognize satisfaction patterns of its end-users, leading to identification of the problematic areas, implement remedial measures through change in management policies and strategies.

Talking about cases of I.C.T. related security breaches; here we mention a few international and international cases and studies.

Rita Tehan (2007) cites a report compiled by Knowledge Services Group titled Data Security Breaches: Context and Incident Summaries and that highlights that more than half of the security breaches occurred at institutions of higher education in USA. Some of these breaches include stealing of Names, Social Security numbers, etc. of students and employees from Chicago Public School. Name, bank account details, Social security number from Univ. of California – Campus server in the year 2007 is yet another example of security breaches[30].

In 2009, Accenture conducted a study about network security breaches in enterprises of all sizes and found that system and technical glitches claimed 36% as the major cause of network breaches while negligence of employees became cause of 24% incidents[2].

In India also there have been cases of website hacking of higher education institutions. Wi-Fi networks of Higher Education Institutions have also been used in an unauthorized manner. Researcher has also observed and heard informally from students that though they were told that computers and labs are installed but either the computers were not there or else they were not in working condition despite norms set up by AICTE, UGC and other higher education governing bodies.

To conclude the researcher would like to emphasize that this research work would greatly help in improving the I.C.T. infrastructure of the Institutions imparting Higher Technical Education in India. This improvement can be done by carrying on fact finding work regarding User issues, security issues and general lookout of the management of these institutes. This gap analysis will finally pave the way to create an effective framework for the management of I.C.T. infrastructure which is economical to set-up and run on one side while on the other it is secured to the expected levels. Thus, this research is of great interest from the national point of view.

1.12 RESEARCH JUSTIFICATION

Continuous advancement in technological segment leading to growing global competitiveness for jobs requiring highest level of skills, requires the universities and other institutions of higher education like engineering, management, pharmacy, architecture colleges to regularly upgrade their I.C.T. Infrastructure systems.

I.C.T. is not a onetime investment. It needs recurring expenses for upgrades, and maintenance accompanied with manpower support to keep the infrastructure running as per the needs of the day. Their effectiveness depends on whether they are able to deliver envisaged results as per user's expectations, organizational needs and goals, legal and compliance requirements, and most of all the security of the digital assets.

Many such institutions don't have the enough resources and manpower to dedicate exclusively towards the complex I.C.T. infrastructure and environment maintenance and monitoring tasks. Significant investment is needed for taking up such challenges[34].

The study of I.C.T. infrastructure facilities and I.C.T. enabled services provided in higher technical institutions is a great learning paradigm to understand and enhance the readiness of such institutions for the digital revolution in India especially in academic fraternity. The findings of the study will rebound to the society and students, in particular, considering that I.C.T. has been identified as a major tool for the purpose of knowledge dispersion. The goals of this study will help bring the I.C.T. setup and facilities to a stage where it will help institutions develop teaching-learning skills that will help students in acquisition of knowledge for gaining employment and giving their full participation in country's development.

By understanding the needs of the students including other stakeholders and the benefits of quality I.C.T. setup, these teaching staff and students be assured of a competitive edge in the world market.

The objectives of the study are designed to help government as well as Management of Institutions identify the I.C.T. facilities that are in place and find the areas which are lacking behind, as per norms prescribed by AICTE and the expectations of the stakeholders, so that all stake holders get world class I.C.T. facilities in their institutions and the data is also in safe hands.

As Pune is not only an academic hub but also an industrial hub on the world map so the results of this study can even be used as an example to create a bigger picture of the scenario at the national level.

If suggestions are implemented the biggest beneficiaries of the study will be students who, through the use of I.C.T. facilities in the institution, will be able to improve academic competence, develop employability skills, gain knowledge from latest research papers and books available online.

This research study aims to develop a theoretical framework which will assist the Higher Education Institutions' in their management of the I.C.T. infrastructure, the impact ofI.C.T. infrastructure on end users, benefits realization and the challenges being faced in maintaining these systems.

1.13. ORGANIZATION OF THE RESEARCH

This research consists of 5 Chapters.

Chapter 1: INTRODUCTION

Highlights the background information &motivation for the research in the area of I.C.T. infrastructure in Institutions imparting Higher Technical Education.

Chapter 2: REVIEW OF LITERATURE

This section consists of research papers and articles published in various national and international journals, periodicals etc.that have been reviewed by researcher. These pertain to I.C.T. infrastructure in higher technical educational systems and reviews on evaluation of on I.C.T. infrastructure, done by previous research so far. Literature Review on Information and Communication Technology Security as well as User satisfaction trends related to I.C.T. infrastructure also makes it to this section.

Chapter 3: RESEARCH DESIGN AND METHODOLOGY-

This section discusses the Research methodology including the research design, sample design, data collection instruments and their descriptions, etc.

Chapter4:DATA PRESENTATION, ANALYSIS AND INTERPRETATION

Contains the analysis of the survey results and analysis and interpretation

Chapter 5:FINDINGS, SUGGESTIONS AND SCOPE FOR FURTHER RESEARCH

Contains research findings, conclusions, and suggestion. It summarizes the study which concludes by examining the contributions of the research. It presents recommendations for future continuation of work in same or similar field. It also contains details of framework designed to implement gaps found in I.C.T. infrastructure in Institutions imparting Higher Technical Education through this study.

SUMMARY:

The researcher has given a brief background of evolution of I.C.T.. Further, the importance of education as a tool of nation building and how I.C.T. has contributed to education has been discussed. A brief introduction into the research being done in course of this study and the significance of this study has been briefed upon. The objectives of the study are designed to help government as well as Management of Institutions identify the I.C.T. facilities that are in place and find the areas which are lacking behind. Conducting the study in an educational and industrial hub Pune can even be used as an example to create a bigger picture of the scenario at the national level. If suggestions are implemented the biggest beneficiaries of the study will be students who, through the use of I.C.T. facilities in the institution, will be able to improve academic competence, develop employability skills, gain knowledge from latest research papers and books available online.

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CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

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**[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[16].

2) A study article by **C. N. Mahopatra**[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.[14]

3) A study paper by **N. D. Oye, N. Aiahad, and A. B. Raheem**[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.

4) A Study article by **A. S. Sodiya, S. A. Onashoga, O. D. Rosanwo, and B. H. Lawal**[6]. titled, "Managing ICT Infrastructure in Higher Educational Institutions", published in the 3rd 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 conducta 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 wereinsufficient (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.**[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**[23]paperpublished 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**[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 frominstalling 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**[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 usefulfor 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 tele-communication 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**[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**[12], 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**[39], 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. Majumdar**[10]., 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. Powar**[33] 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. Fisher**[31] 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 thetraditional classroom model. [31]

17) A study paper by **S.S. Motebennur Dr**[47]**.**, 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 toimprovethe 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**[21] 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 segmenthasturned 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 andinformation 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. Theseinclude 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 theICT 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 ICTincreases the managerial effectiveness and efficiency of the higher education institutions.[52]

22) A study article by **A. Kumar & A. Kumar**[4], 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. Suri**[24], published in this special interest group of CSI. Author has conducted a comparative study of universities in Span 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. Joshi**[50], published in the International Journal of Management Technology, volume 3, number 1. This study strives to study the role of ICT in in relation to the enhancement of quality and management of education in higher education sector during the period from 2004 to 2011.Authorshave 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**[37], theauthor has opined that, rapid and continuous changes in the societyplacesnew 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.[37]

26) A study paper by **K. Balasubramanian, W. Clarke-Okah, &J. Daniel**[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.[29]

27) A study paper by **U. Fredriksson, E. Gajek, &G. Jedeskog**[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**[1], 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, ICTtechnologies usage is limited and that they are used in a veryun-coordinated manner. It is also observed that there is a lack of ICTbased communication channels like e-mail, web based media, and the communication networks are disjointed. Also there is a lack of knowledge & awareness regarding ICTamong the management staff and there are no specific plans for development and implementation of ICT.[1]

29) A study paper by **K. Bingimlas**[30], 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[22], 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 becauseICT 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. Mete**[5]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. Traore**[19]**,**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**[34]**,** 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 ICTsecurity especiallyregarding their perceptions regarding their responsibility towards ICTsecurity 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 mis-understood 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.[34]

5) A study paper by **S. Guillaume, H. Carlo, A. Matthieu, J. Marianne, & M. Romain**[45], presented in the 9thInternational 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 calledVoozio2.7. 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 passable 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. [45]

6) A study paper by **D. Bhatia**[18],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 un-authorized 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. Shrivastava**[7], 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. Rahman**[9], 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 annuals 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]

9) A report by **N. Robinson, B. Horvath, J. Cave, &M. Klaver**[44], titled, "Data Security Breaches And Cyber Security Strategies In The EU And Its

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. Tehan**[42], 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. Dodge**[2], titled, “Information Security Breaches In Higher Education Institutions”, The author has published this study asEducational Security Incidents (E.S.I.)Year Review report for the year 2009. Through the study author has examined variousinformation 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**[51], 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**[3], 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 otherissues may affect the end-user'sperception 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**[40], 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]

15) A study paper by **M. Jones**[35], titled, “An Evaluation Of privacy And Security Issues at A Small Universities”, Published inThe 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)[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**[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**[27].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**[26]. IIM Ahmadabad, has provided A state-of-the-art computer network with more than 2000 PCs connected with campus-wideFibre 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.
6. Home page for Individual students.
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.
9. High internet bandwidth.
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 fee, 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 towards 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 tiled Design and Implementation of a Secure Campus Network have suggested certain important points with regards to setting up of 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**[54]. 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**[55]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

Norms followed for creating ICT infrastructure.	**ICT implementation support source**	**Total number of Support Staff**	**Type of PCs and Servers**
Internet Speed (Bandwidth) subscription.	Intensity Level of ICT attacks encountered.	Role in ICT Security Policy framing.	Presence of ICT up-gradation policy.
No. of Licensed Antivirus software available for PCs and Servers	Factors influencing increase in ICT security attacks / lapses	Factors which help reduce / prevent ICT security lapse or attack	Purpose of using institution's ICT infrastructure
Percentage of Annual Budget is set aside for ICT and Actual expenditure Percentage made on New purchases / Up-gradation of ICT	Success factors influencing reduction / prevention of ICT security lapse.	Areas providing benefits and maximum Return on Investments on ICT.	Availability of Wi-Fi
Audit frequency	Maintenance of Internet usage logs	Drafted ICY policy in the institution and its display in the institution.	

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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CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

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3.0 INTRODUCTION

This chapter deals with the Research Methodology related to the research study of the I.C.T. (Information Communication Technology) infrastructure facility and it's various associated services that are provided Institutions imparting Higher Technical education.

This includes evaluating the I.C.T. infrastructure available in higher technical education institutes, the trends in user satisfaction and security issues involved. The Higher Technical Education Institutions / Universities under study belong to the Pune region.

To attain the objectives of the study the researcher has designed a Descriptive study coupled with sampling methods which are able to depict the population trends. Questionnaires have been used as the key data collection tool which are available for both online as well as offline surveys.

According to data published by the A.I.C.T.E. (All India Council for Technical Education, New Delhi), the Apex body for governing and monitoring Higher Technical Education in India, the population of Institutes, Head of Institution, Full-time Teaching Staff and Learners (Full-Time enrolled Students only) is 545, 545 (approx.),51387 and 709016 respectively in the state of Maharashtra.[1][2][3][4][5][6]

Looking at this huge population size, it is understandable that collecting data from such a big population requires an enormous task in terms of human effort, time and finance. It is also unrealistic and inconvenient to collect data from each institute and each and every respondent from these institutions. Thus, it is more feasible to choose an appropriate sample, using an appropriate sampling method, which is able to represent the whole population trends.

It is also worth noting that due to unavailability of complete and reliable data about I.C.T. infrastructure facilities, I.C.T.usage patterns, implementation details, etc. in

Institutions imparting Higher Technical Education, it is, therefore, not possible to identify perfect population and a perfect sample.

This research work was conducted using Survey Instrument (a Structured Questionnaire) made available online on GoogleDocs and also paper-based. Four different Questionnaires were created for the different types of respondents namely Head of Institute (including Owners, Directors, Principals, HoDs, etc.), Technical Staff, Learners (Full-time students) and Full-time Teaching staff depending on what type of information each individual type of respondent could provide.

As part of the survey process, Researcher visited a number of institutions and met these respondents personally to get the questionnaires filled. The researcher also sent the links of the Questionnaire (Google Form) online via email to Head of Institute, I.C.T.Administrators(s) or Technical Staff, Teaching Staff members whose contact details (particularly email) are known. WhatsApp was also used to send questionnaire links. The contact details of many Head of Institute and faculty members were found on A.I.C.T.E, DTE and University websites.

Researcher also personally met the respondents where online contacts were not available. Majority of student's responses were taken by researcher personally as the student contact details are not readily available online.

Survey results will ultimately help researcher identify the underlying trends of I.C.T. infrastructure facilities implementation in Institutions imparting Higher Technical Education and perceive the user satisfaction for the I.C.T. infrastructure and associated services along with the I.C.T. security involved thereby giving essential assistance for fixing up gaps in I.C.T. implementation. This will certainly help in providing better I.C.T. infrastructure facilities and services to the students and help in their education and career.

The process of identifying a sample for the purpose of Survey involves finding the right type of Learners (Full-time students) and Full-time Teaching Staff members who are using the Higher Technical Education Institution's I.C.T. infrastructure and have been impacted by it as they are directly or indirectly interacting with it on their daily basis. Like-wise I.C.T. Technical Support Staff have been roped-in for answering technical questions, whereas, financial and strategy-related questions have been directed towards the Head of Institute who have ample relevant knowledge and data.

Questions regarding user satisfaction and ways to improve satisfaction, etc. have been targeted to end-users i.e. Students and Teaching Staff.

The respondents that were invited to participate in this survey process have been arranged into 4 groups based on their role in the higher technical education institute which are as following:

a) **Head of Institute:**Owners or Director or Principal or HoDs of Colleges / Institutes / University departmental or appropriate Managing Authority.

b) **I.C.T. Technical Support Staff:** I.C.T. Support Staff Members of Institutions imparting Higher Technical Education.

c) **Full-Time Students:** Learners of different University, Institutes and department of Institutions imparting Higher Technical Education.

d) **Full-time Teaching Staff** members of Institutions imparting Higher Technical Education.

Additionally, white papers, case studies, websites of educational institutions, industry sources, have been used as source of Secondary data along with traditional sources of professional journals and publications.

3.1 PROBLEM STATEMENT

India is fast emerging as the educational hub of the world. Government of India is trying its level best to put India's education system on the world platform. To become a world player in education sector we not only need to teach nicely but need to inculcate knowledge which is in addition to the book knowledge. For this we also need to have world-class I.C.T.infrastructure facilities in educational institutions. This infrastructure not only includes desks and tables in classes and lavish office furniture and good gardens outside the colleges, but we also need study material and a gateway to endless literature and knowledge on various subjects which can be used for teaching purpose and research purpose. Students need computer network facility in schools and colleges which they can be used for preparing lecture sessions, doing assignments, write research papers, etc.

I.C.T. infrastructure installed in higher educational institutions have certain vulnerabilities and threats involved, which if exposed, can be catastrophic to the availability of network facilities for both staff and students and external parties. I.C.T.

infrastructure and data security in higher education institutions is a great point of concern.

There are also issue regarding availability of adequate infrastructure in institutes of higher education.

This makes the study of various aspects I.C.T. including computer network management in higher educational institutions a vital area of research.

Thus, Statement of Problem can be summarized as

"To study the I.C.T. infrastructure facilities and services as providedbyInstitutions imparting Higher Technical Education with respect to its Management including security aspects. Also,tounderstand the user satisfaction patternand problems associated with these facilities with an intent to suggest remedial measures in order to avoid loopholes so as to obtain envisaged results".

Thus, this research study endeavours to identify the problems related to the I.C.T. infrastructure facilities available in the institutions of higher technical education. It also endeavours to identify the gaps in the I.C.T. facilities provided by Institutions of higher technical education by looking at the satisfaction levels for some of the common I.C.T. services offered such institutions. Furthermore, this research study takes a look into the prevalent security issues faced with regards to I.C.T. infrastructure and digital data assets, thus, identifying security gaps and proposing remedies in order to envisaged results. Lastly, the study also tries to enlist the various benefits which higher education institutions have and/or can achieve by implementation of I.C.T. infrastructure facilities and its various services.

As a final output of this research study the research scholar also suggests a model framework for creating an efficient I.C.T. infrastructure which can provide efficient and economical data security and greater user satisfaction, thus, leading to accomplishment of envisaged results.

3.2 SCOPE OF THE STUDY

The research is limited to the study of I.C.T. facilities that are available in the higher technical education institutions specifically those providing professional courses like MBA, MCA, BE, B.Pharma, etc. It strives to study the various the usage pattern of these I.C.T. facilities by various types of users. Further it strives to study the user satisfaction with respect of I.C.T. facilities and the security aspects of I.C.T. infrastructure in institutions imparting Higher Technical Education. It also strives to understand the benefits accumulated from implementation of I.C.T. infrastructure in the institutes imparting Higher Technical Education. In this way the study strives to understand the management policies, strategies and the decisions which the Management follow when deciding upon the various I.C.T. facilities to be made available in the institution. The policies of the management on various issues including financial decisions very much play an important role in deciding the kind of I.C.T. facility to be made available in the institute, the maintenance issues, usage patterns of facilities, I.C.T.security, etc. of the I.C.T. infrastructure. These ultimately lead to satisfaction or dissatisfaction of the end-users of the facilities specially the students and teachers.

Considering that Pune is regarded as the educational hub of India and has sufficient institutions required for the study, the geographical limitation of the study limited to area in Pune. Going further it takes into consideration only those colleges or institutions which, in particular, are approved by A.I.C.T.E for running that particular course. Only Under-Graduate and Post Graduate degree courses have been considered.

The terms “Institutions imparting Higher Technical Education” for the purpose of our study includes only those institutes that offer higher education in the field Management, MCA, Hotel Management, Engineering and Pharmacy courses approved by A.I.C.T.E, New Delhi. (Refer Annexure for full definition). Only Graduate and Post graduate courses have been considered. Diploma courses are not covered for the purpose of this study.

As observed, most Management colleges in Pune region also run MCA course and share resources. Hotel management on the other hand is more of a management subject and has very small representation in the population. Thus, these 3 courses have been taken under “Management” itself. Only MBA, MCA (excluding under commerce, or science), Hotel Management degrees have been considered. No diploma (Under-graduate or Post-graduate) make it to this list.

With respect to “Pharmacy”, only those institutions conducting A.I.C.T.E approved B. Pharma, M. Pharma courses have been selected. No diploma courses make it to this list.

“Engineering Colleges”, on the other hand, include those institutions running Graduate or Post Graduate degree courses viz. B.E., M.E., B.Tech, B.Arch and M.Arch. The population of A.I.C.T.E approved Architecture colleges is very low and, moreover, architecture has more traits of engineering involved in it, so these colleges have been included as part of Engineering colleges. Diploma courses are not included here.

The selection of respondents for the research is carried out for each Institute under the following category:

1) Head of Institute

2) Full-time Teaching Staff

3) Full-time Students(Learners)

4) I.C.T. Technical Support Staff.

The researcher has considered the Pune district for the study. The primary attributes that make Pune the most feasible areas to conduct the said study are as following:

a) The second largest city in the western Indian state of Maharashtra and has history even older than Mumbai. The district has geographical area of 15.642sq.km.

b) It is known for its educational facilities boasting of 9 universities, educational institutions of National Importance, having more than three hundred educational institutes. Savitribai Phule Pune University and Symbiosis are reputed world-wide. Thus, also called "The Oxford of the East".

c) It has high literacy rate.

d) Higher Technical Education institutions are present in rural area also.

e) It has growing industrial facilities and has got a big name in heavy industries, automobile sector and Information Technology.

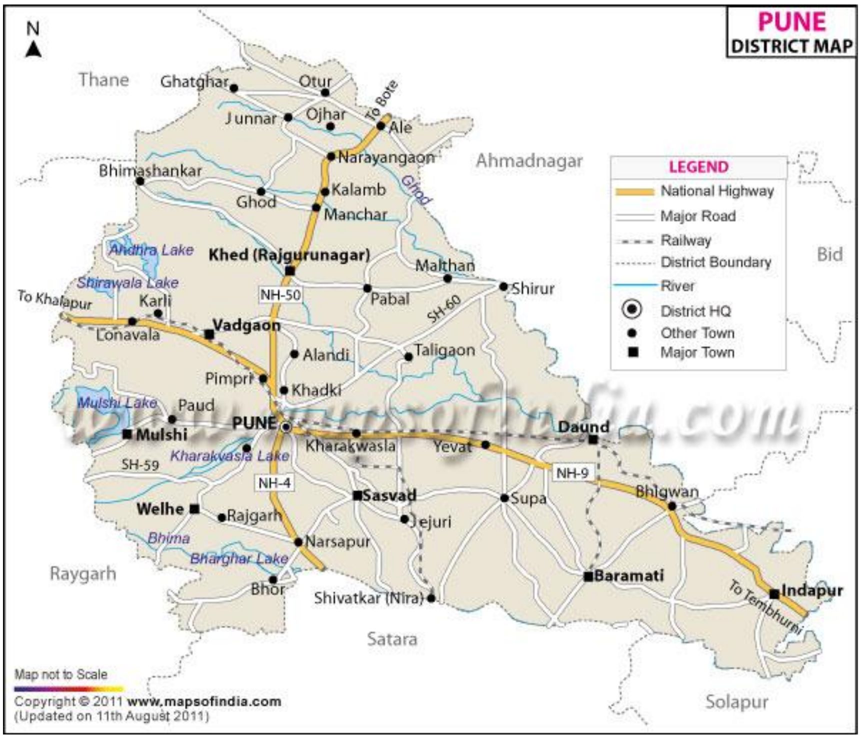
f) Pune district was centre of administration during Peshwa era and is district headquarter even today.

g) Students enrolled here belong to Pan-India and has ample number of foreign students.

Thus, Pune has been found to be the best area for conducting such type of study.

Map 3.1 depicts the map of Punedistrictalong with the names of important Talukas.

Map3.1 : Location of Pune district (Maharashtra)[9]



3.3 OBJECTIVE OF THE STUDY

The researcher has set primary Objectives as given below:

1) To study the I.C.T. infrastructure facilities and I.C.T. enabled services provided by institutions.

2) To study user satisfaction with regards to I.C.T. facilities and services provided by institutions.

3) To identify gaps in Management of I.C.T. facilities and services with special emphasis on I.C.T. security and identify solutions from management perspective in order to receive envisaged results.

4) To study the benefits of use of I.C.T. facilities and services in institutions including their impact on day to day functioning of the institutions.

5) To suggest a theoretical model to improve efficiency of I.C.T. in Institutions imparting Higher Technical Education.

3.4 HYPOTHESES OF THE STUDY

In order to achieve the objectives, as mentioned in section 3.3, the researcher has put forward the following hypothesis for testing:

HYPOTHESIS 1:

H_0: There is No significant difference in availability of basic I.C.T. facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.

H_1: There is a significant difference in availability of basic I.C.T. facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.

HYPOTHESIS 2:

H_0: Institution's I.C.T. security policy has NOT been able to secure I.C.T. infrastructure of the institution.

H_1: Institution's I.C.T. security policy has been able to secure I.C.T. infrastructure.

HYPOTHESIS 3:

H_0: I.C.T. security policy document created by the institute's Management is NOT displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.

H_1: I.C.T. security policy document created by the institute's Management is displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.

3.5 SIGNIFICANCE OF THE STUDY

The study of I.C.T. infrastructure and I.C.T. enabled services provided in higher technical education institutions is a great learning paradigm to understand and enhance the readiness of such institutions for the digital revolution in India especially in academic fraternity.The findings of the study will rebound to the society and students, in particular, considering thatI.C.T. has been identified as a major tool for the purpose of knowledge dispersion. The goals of this study will help bring the I.C.T.

setup and facilities to a stage where it will help institutions develop teaching-learning skills that will help students in acquisition of knowledge for gaining employment and giving their full participation in the country's development.

Higher education institutions are like Small-Medium Enterprise and are confronted by the growing complexity of their IT environment. They need to manage several desktops and notebooks, handheld devices, servers, a network and applications to successfully transact. Many such institutions don't have the depth or resource to dedicate solely towards the plethora of I.C.T. infrastructure maintenance and monitoring tasks in today's complex modern I.C.T. environments. Significant investment is needed for taking up such challenges [8].

Instead of going by words or previous experiences of others in similar situations, it is important to ascertain the current information on the validate it using empirical methods.

Researcher has observed that there is a lack of research that focuses on key factors of I.C.T. infrastructure from the viewpoint of its multiple stakeholders in the context of higher technical educational (professional courses) especially in the Indian perspective.

There is a need to address user's expectations, organizational needs and goals, legal compliance requirements and security of digital assets.

By understanding the needs of the students &other stakeholders, and the benefits arising out of quality I.C.T.facilities, these teaching staff and students be assured of a competitive edge in the world market.

The researcher desires to address the gaps in I.C.T. facilities implementation, highlight problems in I.C.T. security, recognize satisfaction-dissatisfaction patterns of users of I.C.T., thus, leading to identification of the problematic areas for such institutes. The objectives of the study are designed to help government as well as Management of Institutions identify the I.C.T. facilities that are in place and find the areas which are lacking behind so that all stake holders get world class I.C.T. facilities in their institutions and the data is also in safe hands.

Once problems have been identified, this research study aims to develop a theoretical framework which will assist the Higher Education Institutions' in their management of the I.C.T. infrastructure, the impact of I.C.T. infrastructure on end users, benefits realization and the challenges being faced in maintaining these systems.

As Pune is not only an academic hub but also an industrial hub on the world map so the results of this study can even be used as an example to create a bigger picture of the scenario at the national level.

If suggestions are implemented the biggest beneficiaries of the study will be students who, through the use of I.C.T. facilities in the institution, will be able to improve academic competence, develop employability skills, gain knowledge from latest research papers and books available online.

3.6 RESEARCH METHODOLOGY

The study is related to the implementation of I.C.T. infrastructure and its implementation in the Higher Technical education institutions along with I.C.T. security issues involved. It also studies the security issues attached to it. Further, it goes for understanding the user satisfaction attained from it. It, also, strives to understand the economic and strategic benefits accumulated from implementation of I.C.T. infrastructure and its implementation in Institutions imparting Higher Technical education.

The **Descriptive Research Methodology** has been followed in this research study considering the findings from review of literature that some research has been done earlier but a more in-depth and integrated approach is required on the subjects under study in this research work to better understand the underlying trends and problems.

It utilizes both **Primary Data**and **Secondary data** for attaining the objectives set forthfor this study. The secondary data has been sourced from both published as well as un-published sources which includes case-studies, National and International Journals, White Papers, etc. to name a few.

As Primary data is not readily available and it has to be collected from the respondents. These respondents have been categorized into 4 types depending on their role in the institution. Specific questions have been asked from each of these respondent type depending on the type of their associationwith the institution and the knowledge they possess in a particular area related to the study. The scope of research is restricted as explained in the objectives and the scope section.The survey method is used to collect Primary datataking the help of**Stratified sampling technique**to get to an appropriate Sample size which can represent the whole population. Thus,depending on the type and population size of each type of respondents **Stratified Proportionate Sampling**and **Stratified Disproportionate Sampling** has been used.

3.6.1 PRIMARY DATA

The scope of research mandates the collection of primary data from institution which are imparting Higher Technical Education courses (as mentioned in scope) recognized by A.I.C.T.E, New Delhi. For the purpose of the study, the institutions has been **Stratified** into 3 strata viz. Management, Engineering, and Pharmacy.

- **Management Strata:** Consist of institutions providing courses viz. MBA, MCA and Hotel Management.
- **Engineering Strata:** Consist of institutions providing courses viz.BE, ME, B.Tech, B.Arch and M.Arch.
- **Pharmacy Strata:** Consist of institutions providing courses viz. B.Pharma and M. Pharma.

Similarly, the primary data needs to be taken from four different respondent types associated with these institutions viz.:

a) **Head of Institute** Director or Principal or HoDs of Colleges / Institutes / University departmental or appropriate Managing Authority of Higher Education institutes.

b) **I.C.T. Support Staff Members** of Higher Education institutes.

c) **Full-time Students (Learners)** of different University, Institutes and department of Higher Education institutes

d) **Full-time Teaching Staff members** of Higher Education institutes.

The primary data has been collected using a survey instrument which is the questionnaire. Thus, four different types of questionnaires have been designed for each of these respondent types.

The details of Population and Sample for institutions as well as respondents is given in the following sections.

3.6.1.1 SELECTION OF THE PUNE AS GEOGRAPHIC LOCATION FOR SURVEY

As mentioned in section 3.2, the researcher has selected Pune region for the purpose of the study and collection of primary data. Pune region has a rich historic background. It is a historic place and industrial region and has large number of industries including IT and software companies. In general, also Pune is high in literacy rates. Pune is one of the biggest higher education hubs in the country. This makes it possible to get ample number of suitable respondents for data collection.

3.6.1.2 POPULATION AND SAMPLE DETAILS OF INSTITUTIONS IMPARTING HIGHER TECHNICAL EDUCATION

In this section, the researcher has discussed the Population details and sample design for the institutions under study.

For the purpose of the study, the institutions has been **Stratified** into 3 strata viz. Management, Engineering, and Pharmacy.

- **Management Strata:** Consist of institutions providing courses viz. MBA,MCA and Hotel Management.
- **Engineering Strata:** Consist of institutions providing courses viz.BE, ME, B.Tech, B.Arch and M.Arch.
- **Pharmacy Strata:** Consist of institutions providing courses viz. B.Pharma and M. Pharma.

Calculation of Population:

For the academic year 2014-15, as per the A.I.C.T.E dashboard available at http://www.aI.C.T.e-india.org/dashboard/pages/dashboardaI.C.T.e.php, in the state of Maharashtra there are 60,820 full-time Teaching staff, 2,84,420 Full-time Students (UG and PG A.I.C.T.E approved courses), and 1320 institutions running A.I.C.T.E approved courses which forms the universe for the study.

For being included in the population, the institute must fulfill following three criteria, namely:

- The Institute / college / University department must be located in Pune region as Shown in Map of Pune district.

- They must be running a Higher Education course like Management, Engineering or Pharmacy at Under-Graduate and/or Post-Graduate level. (Diploma or Post-Graduate Diploma institutions is not included).
- The course that is being conducted in the institute must be approved by A.I.C.T.E.
- The said institute must be running that particular course for a minimum of 5 years with academic year 2014-15 as the base year.

The criteria of minimum least 5 academic years. As the list of institutions that form the population is from academic year 2014-15, therefore, the institute must be running the said A.I.C.T.E approved course on or before year 2009. This has been done taking 2 important points in consideration:

1) There are enough respondents in the institution.
2) The institution has gathered enough experience, expertise and I.C.T. infrastructure so as to answer the required questions.

Thus, the *total population of institutions comes to 164*. As per the statistics available on A.I.C.T.E website for the academic year 2014-15, it was found that there are 48 Nos. Engineering colleges, 94 Nos. Management colleges, and 21 Nos. pharmacy colleges in Pune. The details of population and sample are shown in the Table 3.1.

Note:

i. **As it a university department which is actually running a higher technical education course like Management, etc., therefore, it is the particular university department / affiliated college that has made to the list of the Population under study and not the University as a whole.**

ii. We are not considering colleges, institutes or university / university department separately. They all have been given equal weightage as an institute providing a particular course.

Table3.1: Institution Population and Sample

Sr. No	Institute Type(Strata name)	Total Institute Population in Pune
1	Engineering Colleges	48
2	Management Colleges	94
3	Pharmacy	21
Total		164

Note: This Population list includes only those institutes which were established in or before 2009.

3.6.1.3 POPULATION AND SAMPLE DETAILS OF SAMPLE (RESPONDENTS)

I.C.T. infrastructure implementation, management, usage, etc. are quite a big and inter-woven processes. These processes are performed by different set of people and it is hard to find respondents who know all these processes. Also, the perception of these respondents towards I.C.T. is different as the role they play with regards to I.C.T. in colleges / institutions is different.

As for example, a student doesn’t know about which I.C.T. security equipment (like Router, etc.) is being used in their college. This domain comes in the area of I.C.T. technical Support Staff.

Thus, Respondents for this study belong to three categories and are chosen to provide better representation of each side. The three categories are Head of Institution, Full-time Teaching faculty (staff) members, Full-Time Students and I.C.T. Technical Support Staff.

In this section the Researcher has described the rationale behind calculation and selection of population and sample of the respondents.

Type A: Selection of Head of Institute

In case of selection of sample size for this category, we need to use **Stratified Proportionate** sampling method. The reason for this is that the number of Head of Institute in each college is generally one for the whole college or a particular course.

Hence for study purpose, researcher has used 1:1 ratio for Head of Institute (Refer Table 3.2).

Table 3.2: Sample and Respondent Details for Head of Institute

College Type	*Required No. Of respondents in Sample	No. of Valid Responses received
Engineering	34	13
Management	66	20
Pharmacy	15	5
Total	115	38

* Refer Table 3.1

Table 3.2 depicts the sample details for Head of Institute respondents. The researcher tried to cover the full sample of Institutions as mentioned in Table 3.1. Of these few responses were disqualified because of incomplete filling up by the respondents. A few never returned the response questionnaire.

Thus, the number of valid responses of type Head Of Institute is 13 Nos. for Engineering, 20 Nos. for Management, and 5 Nos. for Pharmacy institutes.

Type B:Selection ofI.C.T.Technical Support Staff

Data regarding whichI.C.T. devices have been installed, what services have been provided by the respective institution, security issues, etc. can be best answered by none other than the I.C.T. Technical Support Staff working in the said colleges and so such type of data are collected from I.C.T. Technical Staff. Thus, Purposive Sampling procedures have been maintained.

For collection of data, researcher has applied **Stratified Proportionate** sampling method for these types of respondents. **Stratified Proportionate** method enables each strata to have same proportion of presence in the sample as it has in the Population. This has been done taking in mind that that there is at least oneI.C.T. Technical Support staff in each educational institution. All the selected staff members were personally interviewed by the researcher. Some of the Information is also collected by conducting group discussion with the selected staff members.

It was found that due to UGC and A.I.C.T.E, regulations each institution had some I.C.T. equipment and computers, printers.

Table No. 3.3: Course-Wise Sample Distribution of I.C.T. Technical Support Staff

College Type	*Required No. Of respondents in Sample	No. of Valid Responses received
Engineering	34	56
Management	66	39
Pharmacy	15	16
Total	115	111

*Refer Table 3.1 for Population and Sample details

Table 3.3 depicts the Strata-wise sample of details of I.C.T. technical staff respondents along the total number of Valid responses received. The overall percentage of valid responses received in sample is 79.28%.

As we can see from the Table 3.3, the required number of technical staff responses is 115 Nos. of these 111 Nos. were considered Valid. This is because, out of the total number of respondents approached, few responses were disqualified because of incomplete filling up by the respondents. A few never returned the response questionnaire. These responses have not been included in the Table 3.3.

Type C: Selection of Full-Time Teaching Staff

For the purpose of this study, the full-time teaching staff has been selected from higher technical education institutes which are situated in Pune region.

A.I.C.T.E, DTE or University websites do not show exclusively the correct faculty members working particularly in Pune region’s Higher technical Education Institutions. Thus, getting an official figure of total number of teaching staff (faculty members) is not possible.

Thus, Researcher has used the total Student Intake for each type of course as an input to calculate Full-time Teaching Staff strength. This Student-Faculty Member ratio is as per norms laid down by A.I.C.T.E in their yearly reference handbooks for Higher Education institutions. Though, the **Student-faculty staff ratio**[7] varies between 1:10 and 1:15 depending on the course type, but for ease of calculations, the researcher has considered it as 1:15 for all courses. (Here, the approved strength of students is considered for all years)

During fieldwork for data collection it was found that Computers, printers, etc. were being used in in each Institute regular basis.

Table 3.4: Course-Wise Sample Distribution of Full-Time Teaching Staff

College Type	Population of Full-Time Students	**Required Student-Faculty member Ratio (As per A.I.C.T.E Norms)	Total Faculty Respondents Population	Sample Size	No. of Valid Faculty Members Responses
Engineering	94983	1:15	6332	242	139
Management	43344	1:15	2889	110	150
Pharmacy	6202	1:15	413	15	43
Total	144529		9634	369	332

The required sample size for a population of 9634 is **369**.

*This sample size has been calculated with Confidence= 95% and Degree of Accuracy/Margin of Error being at 0.05. **Krejcie and Morgan chart**[10] has been used to calculate sample size.

**Kindly note that though there is a slight difference in Student-faculty ration for different courses, a uniform ration of 1:15 has been considered for ease of calculation.

Strata-wise sample for teaching staff is calculated using **Stratified Proportionate Sampling method.**

The researcher had sent around 406 Questionnaires using various methods like post, email and personal interview, etc. many went un-answered or were incomplete making them invalid responses. The actual number of valid responses collected are 332.

Table No 3.4 shows the information of total number of Full-Time Teaching Staff members and sample selection from each category. As seen in the table 3.4, from selected Institutes researcher has received 150 Valid responses from Management, 139 from Engineering, and 43 from Pharmacy.

All the teaching staff members were either personally interviewed by the researcher or were asked to fill responses online. Some of the Information is also collected by conducting group discussion with the selected staff members.

Type D: Selection of Full-Time Students (Learner)

Population of learner (full-time students) in Higher Education institutions in Pune region is very high i.e. approx. 1,44,529. This figure is as per the data available with A.I.C.T.E for Academic Year 2014-15. This data has been retrieved from **A.I.C.T.E website**[1].

Looking at the huge volume of population, the researcher has used **Stratified Proportionate Sampling Method** and selected approx. 2-3 respondents from each institution in each course category as shown in following table 3.5.

Point worth noting here is that that the maximum sample size for a population of 144529 is 384. But, in order to achieve better success rate in data collection and for accuracy of data, the researcher had sent nearly 450 questionnaires of which 435 were found to be valid for research purpose.

Table No. 3.5: Course-Wise Sample Distribution of Full-Time Students (Learners)

College Type	Total Student Respondents Population(all years)	No. of Valid Responses received
Engineering	94983	219
Management	43344	165
Pharmacy	6202	51
Total	144529	435

Table No 3.5 shows the information of total number of Full-Time Students (Learners) and sample selection from each category.

The required sample size for a population of 144529 is **384**. This sample size has been calculated with Confidence= 95% and Degree of Accuracy/Margin of Error being at 0.05. **Krejcie and Morgan chart**[10] has been used to calculate sample size.

As seen in the table 3.5, we find that researcher received much higher number of valid responses i.e. 435 than the required sample size. Of these 219 are from Engineering, 165 are from Management and 51 are from Pharmacy.

3.6.2 SECONDARY DATA

The Researcher has used secondary data for understanding the past studies done or undertaken w.r.t. the I.C.T. infrastructure available in institutions of Higher Education coupled with its security and satisfaction trends among users and other stakeholders. The sources of these secondary data are the reputed journals and magazines, newspapers, articles, internet websites and archives. Researcher has also gone through some relevant PhD. thesis works. For collecting this data the researcher has visited various libraries in Pune and Mumbai. This greatly helped the researcher in finalizing the aims and objectives of the current said study and provide future direction for the research work.

3.7 DATA COLLECTION PROCESS

This section deals with the actual data collection process details. It discusses about the various data collection tools used, Pilot Study and the learning's from it, final data collection process, etc.

3.7.1 TOOLS FOR PRIMARY DATA COLLECTION

For the Pilot Study as well as for the final data collection process w.r.t. the primary data, the researcher used the Structured Questionnaires. These were provided to the user in either Printed format or in e-format using the Google forms.

Based on the type of respondent, invited to participate in this survey process, four different structured questionnaires have created. These include:

a) **Questionnaires for Head of Institute (**Director or Principal or HoDs of Colleges / Institutes / University departmental or appropriate Managing Authority)of Higher Technical Education institutes.

b) **Questionnaires for I.C.T. Support Staff Members** of Higher Technical Education institutes.

c) **Questionnaires for Full-time Students (Learners)** of Higher Technical Education institutes.

d) **Questionnaires for Full-time Teaching Staff members** of Higher Technical Education institutes.

As mentioned earlier, these questionnaires have been prepared in both digital form (available on google Forms) and hard copy. Researcher also used telephone survey/email survey, mail questionnaire, personal observation, interviews, etc. for getting the questionnaires filled.

During the course of their development, the questionnaires were reviewed and modified as per suggestions of experts and learning's from pilot study.

Table 3.6: Address of Links to Questionnaires on GoogleDocs

Respondent Type	GoogleDocs URL
Head of Institution	https://goo.gl/forms/o8pjHJam7BAYRcIx2
Full-Time TeachingStaff	https://goo.gl/forms/hSwLVcxfW048eFut1
Full-Time Students	https://goo.gl/forms/yvYeXrwLCrof1SRs1
I.C.T. Technical Support Staff	https://goo.gl/forms/q6eG6pGgVDsk0E8t2

Regardless of the fact that GoogleDocs based questionnaires are nevertheless very good for data collection in survey based research projects, still, Researcher has also collected data on hard copy printed questionnaire from many respondents. One advantage that the researcher perceived from hard copy printed questionnaires is that the researcher was able to meet some respondents in personal. This provided an opportunity to observe the infrastructure officially or un-officially personally. Also respondents sometimes divulged certain facts personally which they, officially, didn't want to put on paper in black-and-white for obvious reasons.

3.7.2 PILOT STUDY

Before the starting of the main data collection stage, pilot study was executed on experimental basis so as to scrutinize whether or not the proposed questionnaires were well-designed so as to be able to capture correct and valid data that could give us desired answers to the objectives and further help in testing the framed hypothesis. Another issue regarding conducting / undertaking this pilot study was to understand the user perception regarding various questions asked in the respective questionnaires coupled with whether questions were understandable by the target respondents.

For the purpose of Pilot study the researcher considered 8 colleges / institutes targeting 20 Full-Time Students, 15 Full-Time Teaching Staff, 8 Head of Institute, and 8 I.C.T. Technical Support Staff Members

The said Pilot Study provided very valuable inputs which helped improving the quality of Questionnaires. Some of the learnings from the pilot study are as following:

- Questions must be asked by correct respondent type especially Technical questions to be asked from only I.C.T. support staff.
- Questionnaires of Head of Institute must be restricted to their functional areas specifically administration, monetary and strategic questions.
- Certain less important questions were to be removed to keep length of questionnaire in control.
- Technical staff respondents were reluctant in giving certain exact details of security implementation as it could compromise with the security. Such questions were reframed and indirect were used in such cases.
- It was found that survey method was suitable for the study.
- It was also realized that Head of Institute respondents were reluctant in giving exact financial figures regarding provisions for I.C.T. in their budget. In this case questions were reframed and figureswere asked in percentage of total budget rather than in amount (Rs.).
- Another learning was that when it came of questions where user perceptions was to be evaluated as for example satisfaction level for certain I.C.T. services, in such a case two staff members from same institute gave two different opinions in certain cases.
- Few more questions were added in I.C.T. technical staff questionnaire to understand availability of minimum I.C.T. infrastructure like Wi-Fi.

Reliability Testing

To check the consistency of the questionnaire to be administered researcher has applied the **Cronbach's Alpha** reliability test.

It is observed that the questionnaire to be administered is consistent throughout the respondents. Reliability coefficient of .70 or higher is considered "acceptable".

For Head of Institute(Cronbach's Alpha =0.709), Full-Time TeachingStaff (Cronbach's Alpha =0.737), Full-Time Students(Cronbach's Alpha =), and I.C.T. Technical Staff (Cronbach's Alpha = 0.923).Further researcher can conclude that the same questionnaire can be administered for the further research.

Table 3.7: Reliability Statistics for Head of Institute

Cases	N	Cronbach's Alpha	N of Items
Valid	8 (100%)		
Excluded[a]	0	0.709	69
Total	**8 (100%)**		

From Table 3.7, it is observed that questionnaire is consistent and that Cronbach's Alpha score is 0.709. It means that 70 percent respondents understood the questionnaire.

Thus, the Researcher concludes that this questionnaire can be administered for the further research.

Table 3.8: Reliability Statistics for Full-Time Teaching Staff

Cases	N	Cronbach's Alpha	N of Items
Valid	15 (100%)		
Excludeda	0	0.737	45
Total	15 (100%)		

From Table 3.8, it is observed that questionnaire is consistent and Cronbach's Alpha score is 0.737. This means 73 percent respondents understood the questionnaire. Thus researcher concludes that this questionnaire can be administered for the further research.

Table 3.9: Reliability Statistics for Full-Time Students

Cases	N	Cronbach's Alpha	N of Items
Valid	20 (100%)		
Excluded[a]	0	0.737	63
Total	20 (100%)		

From Table 3.9, it is observed that questionnaire is consistent and Cronbach's Alpha score is 0.737. It means 73 percent respondents understood the questionnaire. Thus researcher concludes that this questionnaire can be administered for the further research.

Table No. 3.10: Reliability Statistics for I.C.T. Technical Staff

Cases	N	Cronbach's Alpha	N of Items
Valid	8 (100%)		
Excluded[a]	0	0.923	142
Total	8 (100%)		

From Table 3.10, it is observed that questionnaire is consistent and Cronbach's Alpha score is 0.830. It means 92 percent respondents understood the questionnaire. Thus researcher concludes that this questionnaire can be administered for the further research.

SUMMARY:

In case of this particular research, the data collection process was a tedious one. Where it came to collect data personally, the respondent had hard time to get inside certain institutes. More over the sample size of Students and teaching staff was quite high. Another problem faced by researcher was that of getting an appointment from Management representatives i.e. Directors and Principals.

A.I.C.T.E list also contained redundant list of institutions. This was because of the shift system namely First Shift and Second shift. If an institution was having both shifts, the name of the institution appeared twice. Thus, such duplicate names were removed from the population list. Once data was collected and tabulated, it was then coded and fed into SPSS software for analysis work.

In all 916 valid questionnaires were recorded.

Table No. 3.11: Summary Chart of Respondents Sample

S. No	Institution type	Respondent Type	No. of Valid respondents in Sample	Total
1	Engineering	Head of Institute	13	427
		Full-Time teaching Staff	139	
		Full-Time Students (Learners)	219	
		Technical Support Staff	56	
2	Management	Head of Institute	20	374
		Full-Time teaching Staff	150	
		Full-Time Students (Learners)	165	
		Technical Support Staff	39	
3	Pharmacy	Head of Institute	5	115
		Full-Time teaching Staff	43	
		Full-Time Students (Learners)	51	
		Technical Support Staff	16	
Total				916

Table No. 3.12: Summary of Sample

	I.C.T. Technical Staff	Full-Time Teaching Staff	Full-Time Students	Head of Institutes
Population description	No. of I.C.T. Technical support staff	No. of Teaching Staff from Institutes working full-time	No. of enrolled students from different Institutes (only full-time)	Director/ Principal/ HODs/ Institute owners
Population size	1 per institute (163 Nos.)	Total number of full-time teaching staff in ratio of total enrolled students. (9634)	Total no. of full time enrolled (sanctioned) students in A.I.C.T.E approved courses in all years (144529)	1 per institute (163 Nos.)
Sample size required as per Krejcie and Morgan Chart (Confidence= 95% and Degree of Accuracy/Margin of Error being at 0.05)	115	369	384	115
Actual no. of VALID responses	111	332	435	38
%age of Total Population	68.10%	3.45%	0.03%	23.31%
Sampling Method	Stratified Sampling Method			

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CHAPTER 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

CHAPTER 4

DATA PRESENTATION,

ANALYSIS AND INTERPRETATION

4.0 INTRODUCTION:

This research is related to the study of management of ICT (Information and Communication Technology) infrastructure facilities and services available in higher technical educational institutions located in Pune region, including its security aspects.

For the purpose of the study, the respondents have been divided into four types. Type A consists of Management of the institute who make policy decision, Type B consists of Full-time Teaching Staff who avails the ICT facilities in the institute, Type C are the Full-time students (Learners)who avail the ICT facilities, and Type Dare the Technical Staff who are responsible for the set-up and maintenance of ICT infrastructure facilities and services in the said educational institution.

The Institutions have been stratified into 3 types depending on the course they are conducting namely Management, Engineering and Pharmacy institutions. Please note that respondents are selected only from those institutions who are running AICTE approved courses and the respondents are also only those who are attached to that particular AICTE approved courses.

The details of each type of respondents and sample size is shown in Table 4.1

Table 4.1: Respondent Sample details

Sl. No	Institution Type	No. of Institutes	Respondent Type	No. of valid responses in Sample	Total
1	Engineering	45	Head of Institute	13	427
			Full-Time teaching Staff	139	
			Full-Time Students (Learners)	219	
			Technical Support Staff	56	
2	Management	75	Head of Institute	20	374
			Full-Time teaching Staff	150	
			Full-Time Students (Learners)	165	
			Technical Support Staff	39	
3	Pharmacy	20	Head of Institute	5	115
			Full-Time teaching Staff	43	
			Full-Time Students (Learners)	51	
			Technical Support Staff	16	
				Total	**916**

Table 4.1 shows the distribution of respondents from each of the courses under the categories viz. Engineering, Management and Pharmacy. As shown in the table 4.1, the total number of Head of Institute (Management of the institution)respondents (valid responses) is 38 (Engineering: 13, Management: 20 and Pharmacy: 5).The total number of Full-time teaching staff respondents (valid responses) is 332 (Engineering: 139, Management: 150, Pharmacy: 43). The total number of Full-time students (Learners) respondents (valid responses) is 435 (Engineering: 219, Management: 165, Pharmacy: 51). The total number of Technical Support Staff respondents (valid responses) is 111 (Engineering: 56, Management: 39, Pharmacy: 16).

The data has been collected using structured Questionnaires and interviews. The collected data has then been compiled, tabulated, coded for further analysis which has been done using statistical tools like Microsoft Excel and IBM's SPSS software.

Statistical parameters and graphics have been used wherever necessary and useful.

4.1 PRESENTATION AND ANALYSIS OF PRIMARY DATA:

The presentation and analysis of primary data is discussed in 4 parts as per respondent type.

4.1.1 RESPONDENT TYPE 1: HEAD OF INSTITUTE:

For this type of respondent, primary data was collected using questionnaires. For this respondent type,38 Nos. responseswere found to be valid. The respondents under this category are either the owners of Higher Technical Education institution offering A.I.C.T.E. approved courses or were working as Director or HOD in one of such institutes.

In this case the data collection and its analysis is based on following points (excluding certain general institute-related information):

1) Type of Institution
2) Types of Courses (Under graduate / Postgraduate/ both)
3) Total Number of Full-time Students (all years intake)
4) Institute location (urban / rural location)
5) Government aid (Aided / Unaided)
6) Courses conducted (A.I.C.T.E. approved only: Engineering/ Management/ Pharmacy)
7) Total Number of Staff members
8) Norms followed for creating I.C.T. infrastructure.
9) I.C.T. implementation support source
10) Total Number of PCs
11) Total number of Support Staff
12) Type of PCs and Servers
13) Internet Speed (Bandwidth)
14) Extent of satisfactionw.r.t overall I.C.T. infrastructure security

15) Extent of satisfaction w.r.t. overall I.C.T. Digital assets security

16) Intensity Level of I.C.T. attacks encountered.

17) Role in I.C.T. Security Policy framing.

18) Presence of I.C.T. up-gradation policy

19) No. of Licensed Antivirus software available for PCs and Servers

20) Percentage of Annual Budget set aside for I.C.T. and Actual ExpenditurePercentage made on New purchases / Up-gradation of I.C.T.

21) Whether investment in I.C.T. infrastructure is every penny worth spent

22) Areas providing benefits and maximum Return on Investments on I.C.T.

4.1.2 RESPONDENT TYPE 2: FULL-TIME TEACHING STAFF:

For this type of respondent, primary data was collected using questionnaires. For this respondent type 332 Nos. valid responses were received. These respondents are working as full-time paid teaching staff at higher technical education institution running A.I.C.T.E. approved course and teaching only A.I.C.T.E. approved course.

In this case the data collection and its analysis is based on following points (excluding certain general institute-related information):

1) Type of Institution

2) Types of Courses(Under-graduate, Post-Graduate or both)

3) Approval from A.I.C.T.E.

4) Institute location (urban / rural)

5) Total Number of Full-time enrolled Students (Intake including all years)

6) Courses Conducted (A.I.C.T.E. Approved only)

7) Total Number of Full-time Teaching Staff members

8) Total Number of PCs in the institution for the said course

9) Availability Laptops, printers, etc. available to students and staff for use.

10) Type of PCs and Servers available in the institution.

11) Software Type used the institution (Open-source, licensed, etc.)

12) Norms followed for creating your I.C.T. infrastructure.

13) Purpose of using institution's I.C.T. infrastructure

14) Extent of satisfaction w.r.t. to I.C.T. services by the institution

15) Measures to prove improve user satisfaction.

16) Extent of satisfaction w.r.t overall I.C.T. infrastructure security

17) Extent of satisfaction w.r.t. overall I.C.T. Digital assets security

18) Intensity Level of I.C.T.security attacks encountered.

19) Success factors influencing reduction / prevention of I.C.T. security lapse

20) Areas to be addressed to improve I.C.T. security

21) Percentage of Annual Budget is set aside for I.C.T. and Actual Expenditure Percentage made on New purchases / Up-gradation of I.C.T.

22) Whether investment in I.C.T. infrastructure is every penny worth spent

23) Areas providing benefits and maximum Return on Investments on I.C.T.

4.1.3 RESPONDENT TYPE 3: FULL-TIME STUDENTS:

For this type of respondent type primary data was collected using questionnaires. For this respondent type,435Nos. valid responses were received. These respondents are the full-time studentsstudying A.I.C.T.E. approved higher technical education course at one of the institutes in Pune region.

In this case the data collection and its analysis is based on following points (excluding certain general institute-related information):

1) Type of Institution

2) Types of Courses (Under-graduate, Post-Graduate or both)

3) Total Number of Full-time enrolled Students for said course

4) Number of full-time Teaching staff members

5) Institute location (urban / rural)

6) Approval from A.I.C.T.E.

7) Courses Enrolled for (A.I.C.T.E. Approved only)

8) Total PCs

9) Availability Laptops, printers, etc. available to students and staff for use.

10) Software Type used the institution (Open-source, licensed, etc.)

11) Purpose of using institution's I.C.T. infrastructure

12) Extent of satisfaction w.r.t. to I.C.T. services by the institution

13) Extent of satisfaction w.r.t overall I.C.T. infrastructure security

14) Extent of satisfaction w.r.t. overall I.C.T. Digital assets security

15) Identify I.C.T. security lapses

16) Areas for improvement in I.C.T. security.

4.1.4 RESPONDENT TYPE 4: TECHNICAL SUPPORT STAFF

For this type of respondent type primary data was collected using questionnaires from 111 Nos. respondents who are working as I.C.T. Technical Support Staff in Higher Technical Education institution offering A.I.C.T.E. approved courses.

In this case the data collection and its analysis is based on following points (excluding certain general institute-related information):

1) Type of Institution

2) Types of Courses (Under-graduate, Post-Graduate or both)

3) Total Number of Full-time enrolled Students for said course

4) Government Aid

5) Number of full-time Teaching staff members

6) Institute location (urban / rural)

7) Approval from A.I.C.T.E.

8) Courses Conducted (A.I.C.T.E. Approved only)

9) Total PCs

10) Norms followed for creating I.C.T. infrastructure

11) I.C.T. implementation support source

12) Number of I.C.T. Technical Staff employed in the institution

13) Availability Laptops, printers, etc. available to students and staff for use.

14) Type of PCs and Servers used (Branded/ Unbranded)

15) Software Type used the institution (Open-source, licensed, etc.)

16) Speed of internet Connection

17) Type of Internet Connection

18) Purpose of using institution's I.C.T. infrastructure

19) ERNET services used by institution

20) Availability of Wi-Fi

21) Audit frequency

22) Maintenance of Internet usage logs

23) Drafted ICY policy in the institution and its display in the institution

24) Extent of satisfaction w.r.t. to I.C.T. services by the institution

25) Measures to improve user satisfaction

26) Extent of satisfaction w.r.t overall I.C.T. infrastructure security

27) Extent of satisfaction w.r.t. overall I.C.T. Digital assets security

28) Level of I.C.T. security attacks encountered.

29) Role in preparing I.C.T. Policy.

30) Licensed Antivirus software available of PCs and Servers

31) Factors influencing increase in I.C.T. security attacks / lapses

32) Factors which help reduce / prevent I.C.T. security lapse or attack

33) Areas need to be addressed to reduce / prevent I.C.T. security lapse or attack

34) Percentage of Annual Budget is set aside for I.C.T. and Actual Expenditure Percentage made on New purchases / Up-gradation of I.C.T.

35) Areas providing benefits and maximum Return on Investments inI.C.T.

4.2 TO STUDY THE I.C.T. INFRASTRUCTURE FACILITIES AND I.C.T. ENABLED SERVICES PROVIDED BY INSTITUTIONS:

Under this objective the researcher strives to study the I.C.T. infrastructure facilities and services which are been provided by Higher Technical Education Institutions which are conducting A.I.C.T.E. approved courses. It includes the norms followed for implementing the said infrastructure along with certain other valid aspects. Apart from this, study has also been conducted to understand the utilization patterns of these I.C.T. infrastructure facilities and services by various types of users viz. Teaching staff, Students, etc.

4.2.1 ADEQUACY OF PCS IN W.R.T TOTAL STUDENTS ENROLLED:

Here, we analyze whether the number of PCs available in each type of institute is as per the minimum requirements as specified by A.I.C.T.E..

Table 4.2: Trends in Availability of PCs as per Total Number of Students enrolled (all years) as per Responses of I.C.T. Technical Staff responses

No. of PCs / No. of Students		Engineering Colleges: Up to 150	Engineering Colleges: 151 to 300	Engineering Colleges: 301 to 450	Engineering Colleges: 451 and above	Engineering Colleges: Total	Management Colleges: Up to 150	Management Colleges: 151 to 300	Management Colleges: 301 to 450	Management Colleges: 451 and above	Management Colleges: Total	Pharmacy Colleges: Up to 150	Pharmacy Colleges: 151 to 300	Pharmacy Colleges: 301 to 450	Pharmacy Colleges: 451 and above	Pharmacy Colleges: Total
Total No. of Student (all years)	Up to 300	5 (55.6)	2 (22.2)	1 (11.1)	1 (11.1)	9 (100)	6 (46.2)	4 (30.8)	2 (15.4)	1 (7.7)	13 (100)	8 (100)	0 (0.0)	0 (0.0)	0 (0.0)	8 (100)
	More than 300but less than 600	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (55.6)	1 (11.1)	2 (22.2)	1 (11.1)	9 (100)	3 (100)	0 (0.0)	0 (0.0)	0 (0.0)	3 (100)
	More than 600 but less than 900	0 (0.0)	1 (33.3)	0 (0.0)	2 (66.7)	3 (100)	3 (27.3)	1 (9.1)	7 (63.6)	0 (0.0)	11 (100)	2 (40.0)	0 (0.0)	3 (60.0)	0 (0.0)	5 (100)
	More than 900 but less than 1200	0 (0.0)	1 (16.7)	3 (50.0)	2 (33.3)	6 (100)	0 (0.0)	0 (0.0)	5 (83.3)	1 (16.7)	6 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	More than 1200 but less than 1500	0 (0.0)	0 (0.0)	1 (14.3)	6 (85.7)	7 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
	Above 1500	0 (0.0)	0 (0.0)	4 (12.9)	27 (87.1)	31 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.2 depicts Trends in Availability of PCs as per Total Number of Students enrolled (all years) as per responses of I.C.T. Technical Staff responses. As per A.I.C.T.E. rules (Published in approval book for 2014-15) the mandatory availability of PCs should be in the ratio of 1:4 (Engineering Course) i.e. 1 PC for every 4 students enrolled (Full-Time), 1:2 (Management courses) and 1:6(Pharmacy).

Note: in case of Under-graduate engineering courses the required ratio is 1:4 while that for Post-Graduate is for 1:2. As number of engineering post-graduate students is much lesser than under-graduate, therefore, we have taken the ratio of 1:4 for both of them.

Please note that all calculations have been made as per A.I.C.T.E. prescribed norms for the academic year 2014-15.[1][2]

As is evident from Table 4.2, in case of engineering institutes having *Upto 300* students enrolled, 100% institutes have required or more number of PCs. In case of institutes having *More than 300 but less than 600* enrolled students, 100% institutes have required or more number of PCs. In case of institutes having *More than 900 but less than 1200* enrolled students 100% institutes have required or more number of PCs. In case of institutes having *More than 1200 but less than 1500*, 100% institutes have required or more number of PCs.

In case of Management institutes, having *Upto 300* students enrolled, 100% institutes have required or more number of PCs. In case of Institutes having *More than 300 but less than 600 students,* 44.4% institutions have required or more number of PCs. . In case of Institutes having More than 600 but less than 900 students only 63.6%institutions have required or more number of PCs. In of *More than 900 but less than 1200* enrolled students, only 16.7% institutes have required or more amount of Pcs.

In case of Pharmacy institutions, having *Upto 300* enrolled students, 100% institutes have required or more number of PCs. In case of institutes having *More than 300 but less than 600* enrolled students, 100% institutes have required or more number of PCs. In case of institutes having *More than 600 to 900* enrolled students, 100% institutes have required or more number of PCs.

SUMMARY

To summarize, all the engineering institutions having various range of student intake have 100% institutions having required or more number of PCs. Pharmacy institutions also showcase similar trends. Management institutes also depict a similar trend except for institutes having *More than 900 but less than 1200* enrolled students where only 16.7% institutes have required or more amount of Pcs. This means that as the number of intake is increasing in management institutes, the number of PCs is not increased.

4.2.2 TYPE OF I.C.T. IMPLEMENTATION AND MAINTENANCE SOURCE

Table 4.3: Type of I.C.T. implementation and maintenance Source

Implementation Source	Number of Respondents					
	Technical Staff			Head of Institute		
	Yes	No	Total	Yes	No	Total
a. Large general consulting firm	34(30.6)	77(69.4)	111(100)	0(0)	38 (100)	38(100)
b. Independent specialist consultants	36(32.4)	75(67.6)	111(100)	4(10.5)	34 (89.5)	38(100)
c. Vendor support	95(85.6)	16(14.4)	111(100)	36(94.7)	2(5.3)	38(100)
d. Only internal resources	47(42.3)	64(57.7)	111(100)	23 (60.5)	15 (39.5)	38(100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.3 depicts the trend in the type of I.C.T. implementation and maintenance sources used by Institutions to implement I.C.T. infrastructure in their institution. The data is collected from 111 Technical Staff respondents and 38 Head of Institute.

As Table 4.3 depicts, both Technical Staff Responses (85.6%) and Head of Institute's Responses (94.7%) have stated that *Vendor Support* has been most highly used for I.C.T. implementation and maintenance in their educational institutions of higher technical education.

Second choice has been the *Internal Sources* with Technical Staff Responses (42.3%) and Head of Institute's Responses (60.2%).

Table 4.4: I.C.T. implementation and maintenance Source (Integrated)

	Total Yes Responses	Total No Responses	Total respondents
a. Large general consulting firm	34 (22.82)	115 (77.18)	149 (100)
b. Independent specialist consultants	40 (26.85)	109 (73.15)	149 (100)
c. Vendor support	131 (87.92)	18 (12.08)	149 (100)
d. Internal resources	70 (46.98)	79 (53.02)	149 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Graph 4.1: I.C.T. implementation and maintenance source (Integrated)

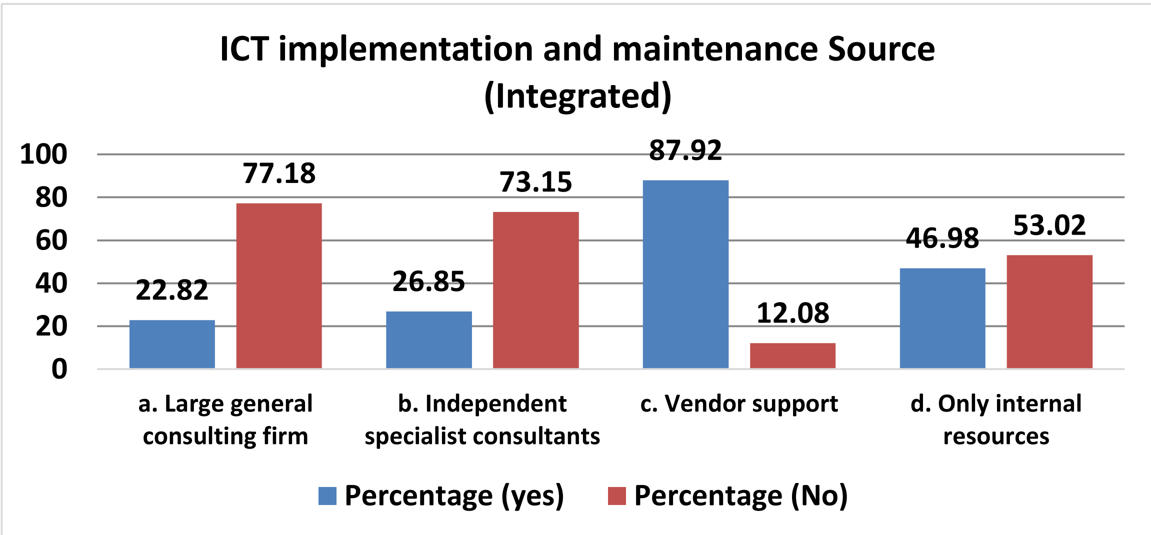
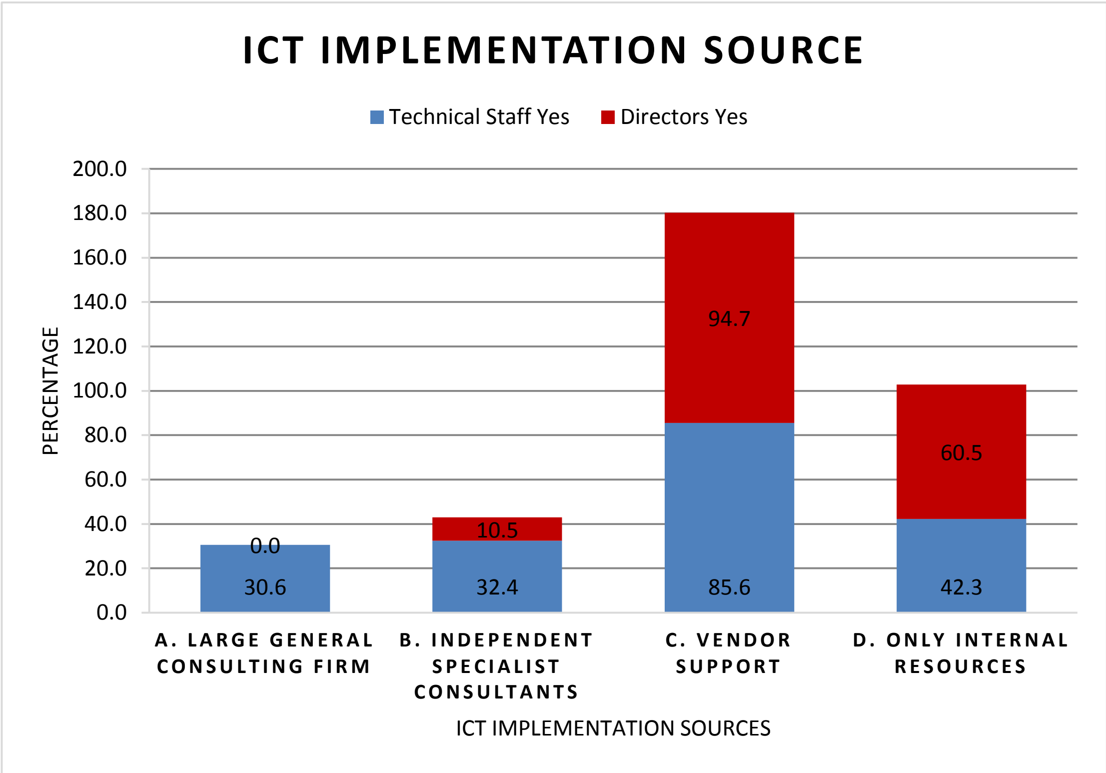


Table 4.4 and **Graph 4.1** depicts the overall trend in the type of I.C.T. implementation Sources used by Institutions to implement I.C.T. infrastructure in their institution. The data is collected from 111 Technical Staff respondents and 38 Head of Institute.

As **Table 4.4** clearly depicts stated that *Vendor Support* (87.92%) has been most commonly used for I.C.T. implementation in the educational institutions of higher technical education. Second choice has been the *Internal Sources* (46.98%). The least choice is *Large general consulting firm* (22.82%).

Graph 4.2: I.C.T. implementation and maintenance Source (Respondent-wise)



Looking at **Graph 4.2**, we find that indeed *Vendor Support* and *Internal Resources* have led the way as the preferred choice for I.C.T. implementation. Another important fact that can be seen from this graph is that educational institutions have least preferred *Large Consulting Firm* with Responses of Head of Institute (0%) and Technical Staff (30.6%) only.

Summary:

As per Head of Institute's responses *Vendor Support* (94.7%) is most used followed by *Internal resources* (60.5%). *Large general consulting firm* (0%) not used at all. Similarly, as per Technical Staff, *Vendor Support* (85.6%) is most used followed by *Internal resources* (42.3%). Some technical staff have reported to have used *Large Consulting firm* and / or *Independent specialist consultants*. But overall, it is the *Vendor Support* (87.92%) and *Internal resources* (46.98%) which top the list of I.C.T. implementation Sources. *Large general consulting firm* (22.82%) and *Independent* *specialist consultants* (26.85%) are least used. Overall it is *the Vendor support* (87.92%) and *Internal resources* (46.98%)which are used most.

4.2.3 NORMS FOLLOWED FOR CREATING I.C.T. INFRASTRUCTURE:

Table 4.5: Norms followed for creating I.C.T. infrastructure

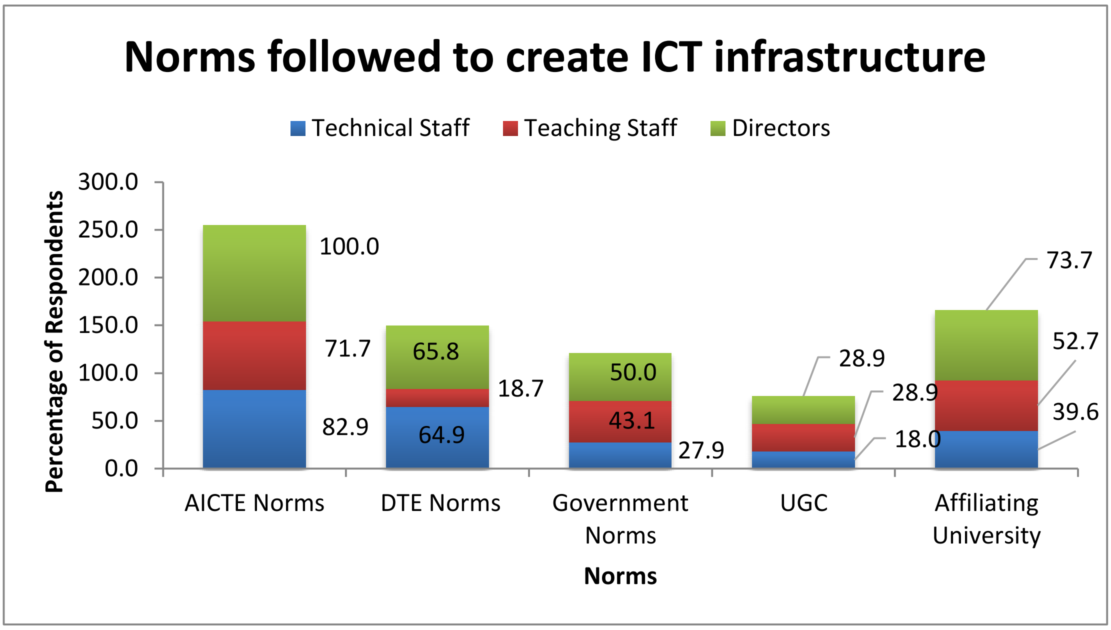
Norms Type	Responses								
	Technical Staff			Full-time Teaching Faculty Staff			Head of Institute		
	Yes	No	Total	Yes	No	Total	Yes	No	Total
A.I.C.T.E. Norms	92 (82.9)	19 (17.1)	111 (100)	238 (71.7)	94 (28.3)	332 (100)	38 (100)	0 (0)	38 (100)
DTE Norms	72 (64.9)	39 (35.1)	111 (100)	62 (18.7)	270 (81.3)	332 (100)	25 (65.8)	13 (34.2)	38 (100)
Government Norms	31 (27.9)	80 (72.1)	111 (100)	143 (43.1)	189 (56.9)	332 (100)	19 (50)	19 (50)	38 (100)
UGC	20 (18)	91 (82)	111 (100)	96 (28.9)	236 (71.1)	332 (100)	11 (28.9)	27 (71.1)	38 (100)
Affiliating University	44 (39.6)	67 (60.4)	111 (100)	175 (52.7)	157 (47.3)	332 (100)	28 (73.7)	10 (26.3)	38 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.5and Graph 4.3 depict the norms which have been followed by higher technical education institutions to create their I.C.T. infrastructure. Data has been collected from 111 Technical Staff, 332 Full-time teaching faculty Staff and 38 Head of Institute.

A.I.C.T.E. Norms have been most followed as Technical Staff (82.9%) where as *UGC Norms* (18%) have been least followed by them.

Graph 4.3: Norms followed for I.C.T. implementation (Respondent-wise)



Full-time Teaching Faculty Staff have also said that *A.I.C.T.E. Norms* (71.1%)has most be followed whereas they have given that the least followed aretheDTE *Norms*(18.7%). On the other hand, Head of Institute have also given view that *A.I.C.T.E. Norms* (100%) have been mostly followed whereas they have given least preference to *UGC Norms* (28.9%)

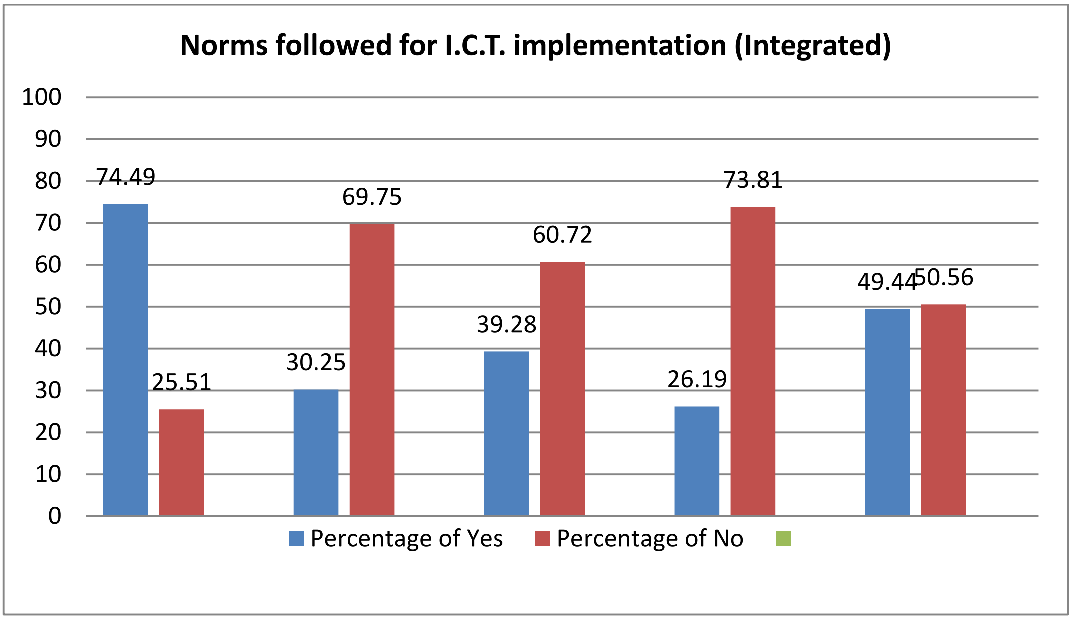
Table 4.6: Norms followed for creating I.C.T. infrastructure (integrated)

Norm	Responses		
	Total Yes Responses	**Total No Responses**	**Total Respondents**
A.I.C.T.E. Norms	330 (74.49)	113 (25.51)	443 (100)
DTE Norms	134 (30.25)	309 (69.75)	443 (100)
Government Norms	174 (39.28)	269 (60.72)	443 (100)
UGC	116 (26.19)	327 (73.81)	443 (100)
Affiliating University	219 (49.44)	224 (50.56)	443 (100)

Table 4.6 (Refer Table 4.5 for further details) depicts the overall trends regarding norms which have been followed by higher technical education institutions to create their I.C.T. infrastructure.

As is evident from results depicted in Table 4.6, it is the *A.I.C.T.E. Norms* (74.49%) which have been most commonly been followed to create I.C.T. infrastructure. This is followed by *Affiliating University Norms* (49.44%).

Graph 4.4: Norms followed for I.C.T. implementation (Integrated)



Graph 4.4 (Ref Table 4.4) shows an integrated view of responses by all the three respondent types i.e. Technical staff, Teaching Staff, and Head of Institute.Overall *A.I.C.T.E. Norms* are most followed for creating I.C.T. infrastructure followed by Affiliating University's Norms, Government Norms, DTE Norms, and lastly UGC Norms. On the other hand, it is the UGC (73.81%) followed by DTE norms (69.75%) that are least followed.

SUMMARY:

As per *Technical Staff, A.I.C.T.E. Norms* (82.9%) have been most followed whereas *UGC Norms* (18%) have been least followed by their institutes. Full-time *Teaching Faculty Staff* have also said that *A.I.C.T.E. Norms* (71.1%) has most be followed whereas the *DTE Norms* (18.7%) have been least followed. *Head of Institute* have also given view that *A.I.C.T.E. Norms* (100%) have been mostly followed whereas *UGC Norms* (28.9%) have given least followed by higher technical education institutions to create their I.C.T. infrastructure. Overall, *A.I.C.T.E. Norms* (74.49%) have been most commonly been followed to create I.C.T. infrastructure. This is followed by *Affiliating University Norms* (49.44%). *UGC Norms* are least followed.

4.2.4 AVAILABILITY OF LAPTOPS, SCANNERS, PCS AND PRINTERS FOR USERS

Table 4.7: Availability of Laptops, Scanners, PCs and Printers for Users as per Technical Staff

Item	Technical Staff Responses							
	Never (1)	Sometimes (2)	Can't Say (3)	Frequently (4)	Very frequently (5)	Total	Wt. Avg.	Rank
PC	0 (0)	0 (0)	0 (0)	55 (49.55)	56 (50.45)	111 (100)	4.5	1
Printer	25 (22.52)	0 (0)	0 (0)	73 (65.77)	13 (11.71)	111 (100)	3.44	2
Laptop	18 (16.22)	51 (45.95)	20 (18.02)	13 (11.71)	9 (8.11)	111 (100)	2.5	3
Scanner	3 (2.7)	92 (82.88)	0 (0)	16 (14.41)	0 (0)	111 (100)	2.26	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.7depicts the Availability of Laptops, Scanners, PCs and Printers for Users as per responses of Technical Staff. 111 Technical responses (valid) were taken for the purpose. The purpose was to find whether PCs, Printers, laptops and Scanners, which belong to the basic I.C.T. infrastructure category, have been made available for the use of Full-Teaching staff, Full-time Students and other users associated with the educational institutions under study. Likert's scale 5-point scale having the following options of Never, Sometimes, Can't Say , Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each Item (e.g. PCs, Printers, etc.) based on Weighted Average calculated for each Item.

As per Technical Staff Respondent's views (Refer Table 4.7), *PCs* have been Ranked at No. 1 followed by *Printers* (Rank 2), *Laptops* (Rank 3), *Scanners* (Rank 4). This implies that according to Technical Staff, the institutions where they are serving PCs are most available for users.

Deeper analysis shows that Technical Staff point out that PCs are 100% Frequently available along with Printers which are 77.48% frequently available. In contract, Laptops are 62.16% Never available and Scanners are 85.59% Never available.

Table 4.8 : Availability of Laptops, Scanners, PCs and Printers for Users as per Full-Time Teaching Staff

Item	Full-time Teaching Staff Responses							
	Never (1)	**Sometimes (2)**	**Can't Say (3)**	**Frequently (4)**	**Very Frequently (5)**	**Total**	**Wt. Avg**	**Rank**
PC	0 (0)	9 (2.7)	7 (2.1)	138 (41.6)	178 (53.6)	332 (100)	4.46	1
Printer	15 (4.5)	68 (20.5)	3 (0.9)	204 (61.4)	42 (12.7)	332 (100)	3.57	2
Scanner	56 (16.9)	121 (36.4)	23 (6.9)	113 (34)	19 (5.7)	332 (100)	2.75	3
Laptop	78 (23.5)	121 (36.4)	22 (6.6)	49 (14.8)	62 (18.7)	332 (100)	2.69	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.8 depicts the Availability of Laptops, Scanners, PCs and Printers for Users as per responses of Full-time Teaching Staff. 332(valid) Responses were taken fromthis category. The purpose was to find whether PCs, Printers, laptops and Scanners, which belong to the basic I.C.T. infrastructure category, have been made available for the use of Full-Teaching staff, Full-time Students and other users associated with the educational institutions under study. Likert's scale 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each Item (e.g. PCs, Printers, etc.) based on Weighted Average calculated for each Item.

As per Full-time Teaching Staff Respondent's views (Refer Table 4.8), *PCs* have been Ranked at No. 1 followed by *Printers* (Rank 2), *Scanners* (Rank 3), *Laptops*(Rank 4). This implies that according to Full-time Teaching Staff, the institutions where they are serving PCs are most available for users.

Deeper analysis shows that Full-time Teaching Staff point out that PCs are 95.20% Frequently available along with *Printers* which are 74.10% frequently available. In contract, Laptops are 59.90% Never available and Scanners are 53.30% Never available.

Table 4.9: Availability of Laptops, Scanners, PCs and Printers for Users as per Full-Time Students

Item	Full-time Student Responses							
	Never (1)	**Sometimes (2)**	**Can't Say (3)**	**Frequently (4)**	**Very frequently (5)**	**Total**	**Wt Avg.**	**RANK**
PC	0 (0)	13 (3.0)	17 (3.9)	166 (38.2)	239 (54.9)	435 (100)	4.45	1
Printer	94 (21.6)	178 (40.9)	14 (3.3)	125 (28.7)	24 (5.5)	435 (100)	2.56	2
Scanner	210 (48.3)	184 (42.3)	12 (2.7)	20 (4.6)	9 (2.1)	435 (100)	1.70	3
Laptop	210 (48.3)	189 (43.4)	14 (3.2)	12 (2.8)	10 (2.3)	435 (100)	1.67	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.9 depicts the Availability of Laptops, Scanners, PCs and Printers for Users as per responses of Full-time Student. 435 (valid) Responses were taken from this category. The purpose was to find whether PCs, Printers, laptops and Scanners, which belong to the basic I.C.T. infrastructure category, have been made available for the use of Full-Teaching staff, Full-time Students and other users associated with the educational institutions under study. Likert's scale 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each Item (e.g. PCs, Printers, etc.) based on Weighted Average calculated for each Item.

As per Full-time Student Respondent's views (Refer Table 4.9), *PCs* have been Ranked at No. 1 followed by *Printers* (Rank 2), *Scanners* (Rank 3), *Laptops* (Rank 4). This implies that according to Full-time Students, the institutions where they are serving PCs are most available for users.

Deeper analysis shows that Full-time Students point out that *PCs*(93.10%)are most Frequently available. In contract, when it comes to *Printers*62.50% say that they are not available for use. Similarly, 91.70% students say Laptops are not available while90.60% Students say that Scanners are not available.

SUMMARY:

As per Technical Staff Respondent's views PCs have been Ranked at No. 1 (100% frequently used) followed by Printers at Rank 2 (77.48% frequently used). Laptops are 62.16% Never available and Scanners are 85.59% Never available. This implies that according to Technical Staff, the institutions where they are serving PCs are most available for users but laptops and scanners are not available.

As per Full-time Teaching Staff Respondent's views, *PCs* have been Ranked at No. 1 (95.20% frequently available) followed by *Printers* at Rank 2 (74.10% frequently available). This implies that according to Full-time Teaching Staff, the institutions where they are serving PCs are most available for users.

In contract, Laptops are 59.90% Never available while Scanners are 53.30% Never available.

As per Full-time Student Respondent's views, *PCs* have been Ranked at No. 1 (93.10% frequently available) followed by *Printers* at Rank 2 (62.50%). *Scanners* (Rank 3), *Laptops* (Rank 4). This implies that according to Full-time Students, the institutions where they are serving PCs are most available for users. *Printers* are 62.50% not available. Similarly, 91.70% students say Laptops are not available while 90.60% Students say that Scanners are not available.

4.2.5 TYPE OF PCS AND SERVERS USED IN INSTITUTIONS

Table 4.10: Type of Servers and PCs used

Respondent Type	**Type of Servers and PCs**			
	Branded	**Non-Branded**	**Both**	**Total**
Technical Staff	67(60.2)	3(2.6)	41(37.2)	111(100)
Full-time Teaching Staff	244(73.5)	2(.6)	86(25.6)	332(100)
Head of Institute	24(63.2)	0(0)	14(36.8)	38(100)

Note: values outside brackets are indicative of Frequency (Number of Respondents) and those inside the brackets indicate frequency in Percentage

Table 4.10 shows the data w.r.t. types of Servers and PCs being used in Technical Higher Education Institutions in Pune region. Primary Data for the purpose has been collected using Structured Questionnaires. Data (valid) has been collected from 111 Technical Staff respondents, 332 Full-time Teaching Staff and 38 Head of Institute.

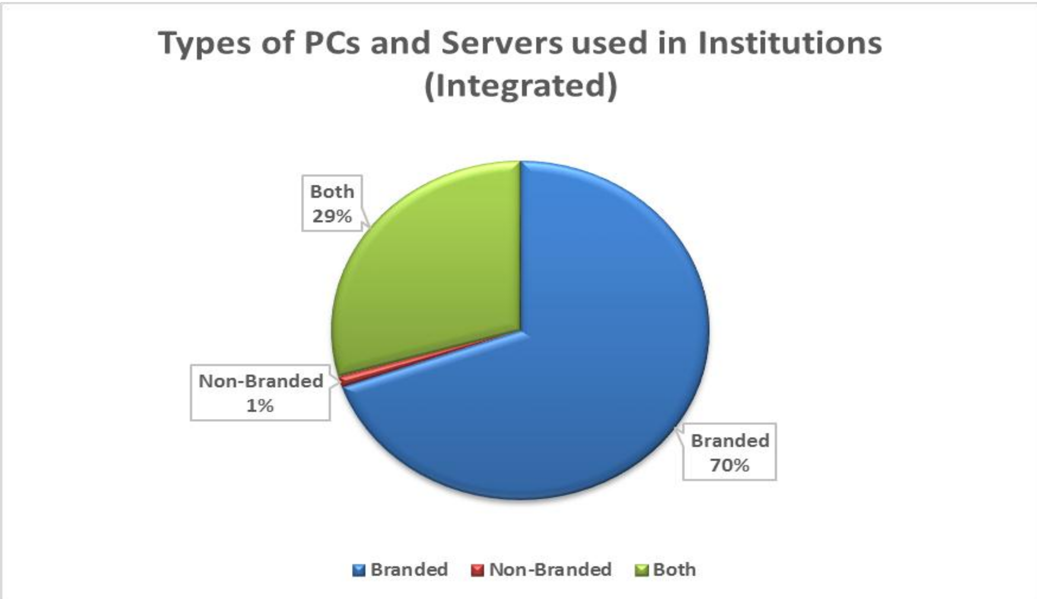
Responses from all the 3 types of respondents (2.6%, 0.6%, and 0.0%) clearly shows that there are very few institutions that are using *Non-Branded PCs and Servers* alone.

Technical Staff (60.2%), Full-time teaching Staff (73.5%) and Head of Institute (63.2%) state that *Branded PCs and Servers* are being used in their institution. Whereas Technical Staff (37.2%), Full-time teaching Staff (25.6%) and Head of Institute (36.8%) state that *Both Branded and Non-Branded PCs and Servers* are being used in their institution.

Table 4.11: Type of Servers and PCs used (integrated)

PC and Server Type	Technical Staff	Full-time Teaching Staff	Directors	Total	Combined Percentage
Branded	67	244	24	335	69.61
Non-Branded	3	2	0	5	1.02
Both Branded & Non-Branded	41	86	14	141	29.37
Total	111	332	38	481	100.00

Graph 4.5: Types of PCs and Servers used in Institutions (Integrated)



Graph 4.5 and Table 4.11depict the Types of PCs and Servers used by educational institutions providing Higher Technical Education in Pune region across all the 3 types of respondents (integrated). It is clearly evident that institutions using *Only*

Branded PCs and Servers(70%) are highest while those using Both Branded and Non-Branded PCs and Servers (29%) comes on the second place.

SUMMARY:

Technical Staff (60.2%), Full-time teaching Staff (73.5%) and Head of Institute (63.2%) state that *Branded PCs and Servers* are being used in their institution.Technical Staff (37.2%), Full-time teaching Staff (25.6%) and Head of Institute (36.8%) state that *Both Branded and Non-Branded PCs and Servers* are being used in their institution.Responses from all the 3 types of respondents (2.6%, 0.6%, and 0.0%) clearly shows that there are very few institutions that are using *Non-Branded PCs and Servers* alone. Overall, institutions using *Only Branded PCs and Servers* (67%) are highest while those using *Both Branded and Non-Branded PCs and Servers* (32%) come on the second place. Also, overall there arevery few number of institutions which are using*Only Non-Branded PCs and Servers*(1%).

This is a good indication because Branded PCs and Servers are obviously good in quality, trust worthy, last long and their performance is also much better than Non-Branded ones. The data is also safe.

One drawback of this data is that that we can’t exactly say the ratio of Branded and un-branded PCs and Servers in cases where institution is using both Branded and Non-Branded PCs and Servers.

4.2.6 TYPES OF SOFTWARE USED IN INSTITUTIONS

Table 4.12: Type of Software used as per I.C.T. Technical Support Staff

Software Type	Responses of Technical Staff							
	Never (1)	Some times (2)	Can't Say (3)	Frequent ly (4)	Very Frequently (5)	Total	Wt. Avg.	Rank
Licensed	0 (0)	12 (10.8)	1 (0.9)	45 (40.5)	53 (47.7)	111 (100)	4.25	1
Open-source	0 (0)	30 (27.03)	2 (1.8)	60 (54.05)	19 (17.12)	111 (100)	3.61	2
Trial version / Unlicensed	6 (5.41)	38 (34.23)	4 (3.6)	63 (56.76)	0 (0)	111 (100)	3.12	3
In-house developed	37 (33.33)	41 (36.94)	8 (7.21)	24 (21.62)	1 (0.9)	111 (100)	2.2	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.12 depicts the usage/availability trends of different types of Software as per responses of Technical Staff. 111 Responses were taken from this category of Respondents. The purpose was to find which type of Software are being used by Technical Higher Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each software type (Licensed, Open-Source, Trial Versions / Unlicensed, In-house developed) based on Weighted Average calculated for each of these items.

As per Full-time Technical Staff Respondent's views (Refer Table 4.12), *Licensed Software* have been Ranked at No. 1 followed by *Open-Source Software* (Rank 2), *Trial-version / Unlicensed Software* (Rank 3), *In-house developed software* (Rank 4). This implies that according to Technical Staff, the institutions where they are serving,most of the software being used are *Licensed* versions. Open-Source software which do not need any type of licensing are also much in use.

Deeper analysis shows that 88.20% technical Staff say that Licensed Software are Frequently used. This is followed by *Open-source software* (71.17%) and *Trial-version software* (56.76%). In contract to this 70.27% respondents say that *In-house developed software* are Never used in their institution.

Table 4.13: Type of Software used as per Full-time Teaching Staff Respondents

Software Type	Responses of Full-Time Teaching Faculty Staff							
	Never (1)	**Some times (2)**	**Can't Say (3)**	**Frequen tly (4)**	**Very Frequently (5)**	**Total**	**Wt. Avg.**	**Ran k**
Licensed	2 (0.6)	4 (1.2)	5 (1.51)	123 (37.05)	198 (59.64)	332 (100)	4.54	1
Open-source	36 (10.84)	63 (18.98)	68 (20.48)	157 (47.29)	8(2.41)	332 (100)	3.11	2
Trial version / Unlicensed	19 (5.72)	137 (41.27)	45 (13.55)	122 (36.75)	9(2.71)	332 (100)	2.89	3
In-house developed	57 (17.17)	187 (56.33)	51 (15.36)	28 (8.43)	9(2.71)	332 (100)	2.23	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.13 depicts the usage/availability trends of different types of Software as per responses of Full-time Teaching Staff. 332(valid) Responses were taken from this category of Respondents. The purpose was to find which type of Software are being used by Technical Higher Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each software type (Licensed, Open-Source, Trial Versions / Unlicensed, In-house developed) based on Weighted Average calculated for each of these items.

As per Full-time Teaching Staff Respondent's views (Refer Table 4.13), *Licensed Software* have been Ranked at No. 1 followed by *Open-Source Software* (Rank 2), *Trial-version / Unlicensed Software* (Rank 3), *In-house developed software* (Rank 4). This implies that according to Technical Staff, the institutions where they are serving, most of the software being used are licensed versions. Open-Source software which do not need any type of licensing are also much in use.

Deeper analysis shows that 96.70%Full-time Teaching Staff respondents say that Licensed Software are Frequently used. This is followed by *Open-source software* (49.7%). In contract to this, 46.99% and 73.49% respondents state that *Trial-version software* and *In-house developed software* respectively are Never used in their institution.

Table 4.14: Type of Software used as per Full-Time Student Respondents

Software Type	Responses of Full-Time Students							
	Never (1)	Sometimes (2)	Can't say (3)	Frequently (4)	Very frequently (5)	Total	Wt. Avg	Rank
Licensed	16 (3.7)	19 (4.4)	83 (19.1)	198 (45.5)	119 (27.4)	435 (100)	3.89	1
Open-source	18 (4.1)	69 (15.9)	14 (3.2)	238 (54.7)	96 (22.1)	435 (100)	3.75	2
Trial version / Unlicensed	12 (2.8)	70 (16.1)	16 (3.7)	329 (75.6)	8 (1.8)	435 (100)	3.58	3
In-house developed	190 (43.7)	207 (47.6)	17 (3.9)	7 (1.6)	14 (3.2)	435 (100)	1.73	4

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.14depicts the usage/availability trends of different types of Software as per responses of Full-time Students. 435(valid) responses were taken from this category of Respondents. The purpose was to find which type of Software are being used by Technical Higher Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each software type (Licensed, Open-Source, Trial Versions / Unlicensed, In-house developed) based on Weighted Average calculated for each of these items.

As per Full-time Students Respondent's views (Refer Table 4.14), *Licensed Software* have been Ranked at No. 1 followed by *Open-Source Software* (Rank 2), *Trial-version / Unlicensed Software* (Rank 3), *In-house developed software* (Rank 4). This implies that according to Technical Staff, the institutions where they are serving, most of the software being used are licensed versions. Open-Source software which do not need any type of licensing are also much in use.

Deeper analysis shows that 72.90% Full-time Student respondentssay that*Licensed Software* are Frequently used which is followed by *Open-source software* (76.80%) and *Trial-version software (77.80%*). In contract to this, 91.30% respondents state that *In-house developed software* are Never used in their institution.

Table 4.15: Type of Software used: Comparison of Ranking across Respondent Types

Software Type	Technical Staff	Full-time Teaching faculty staff	Full-time Students
(a) In-house developed	4	4	4
(b) Open-source	2	2	2
(c) Trial version / Unlicensed	3	3	3
(d) Licensed	1	1	1

(*Refer Tables 4.12, 4.13 & 4.14 for details)

Table 4.15 (Refer Tables 4.12, 4.13 & 4.14 for details) shows a comparison between Rankings given by the different types of respondents regarding Types of Software used. As is clearly evident, there is not too much of a difference in opinions of the 3 respondent types and have Ranked In-House developed software at Rank 1 and Licensed Software at Rank 2.

SUMMARY:

As per Full-time Technical Staff Respondent's views, *Licensed Software* have been Ranked at No. 1 (88.20%) for most usage followed by *Open-Source Software* (Rank 2, 71.7%), *Trial-version / Unlicensed Software* (Rank 3, 56.76%), *In-house developed software* , 70.27% respondents say that *In-house developed software* are Never used in their institution. This implies that according to Technical Staff, the institutions where they are serving, most of the software being used are licensed versions. *Open-Source* software which do not need any type of licensing are also much in use.

As per Full-time Teaching Staff Respondent's views, *Licensed Software* have been Ranked at No. 1 (96.70%), followed by *Open-Source Software* (Rank 2, 49.7%). In contrast, *Trial-version / Unlicensed Software* (Rank 3), *In-house developed software* (Rank 4). In contract to this, 46.99% and 73.49% respondents state that *Trial-version software* and *In-house developed software* respectivelyare Never used in their institution. Trial version software are still being used at many places which indicates that they are under potential security threats.

An important point which has come to the notice is that In-house developed software are not much being used. This means that those institutions which are running Technical courses in the field of computers are not utilizing the skills of their staff and students to practically develop software which could give a good practical exposure to them.

4.2.7 INTERNET SPEED (BANDWIDTH)

Table 4.16: Internet Speed(Bandwidth)

Respondent Type	Internet Speed (Bandwidth)				
	Below 5 Mbps	5 to 10 Mbps	10 Mbps to 15 Mbps	15 Mbps and above	Total
Technical Staff	14 (12.6)	42 (37.8)	50 (45)	5 (4.5)	111 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.16 depicts the *Internet Speed* being used by used by Higher Technical Education Institutions in Pune region as per responses of Technical Staff and Head of Institute. Responses were taken from 111 I.C.T. Technical Staff. The purpose was to find which the Speed of Internet being subscribed and used by Higher Technical Education Institutions in Pune region.

As per Technical Staff's responses *10 Mbps to 15 Mbps*(45%) was the Internet Speed that most Institutions were using whereas *15 Mbps and above* (4.5%) was least been used

SUMMARY:

To summarize, we see that *50 Mbps to 10 Mbps*(41%) has been most subscribed whereas *15 Mbps and above*(4.70%) has been least subscribed. An important point to keep in mind here is that Internet Speed requirement by an educational institute is dependent upon the number of Students enrolled. The more the number of enrolled students the higher the Internet Speed required. Not all institutions have same number of staff and enrolled students. Majority of institutes have less intake of students that's why *5 Mbps to 10 Mbps* Internet Speed has been most frequently subscribed. Same way very few institutes have a very high student intake that's why Internet Speed of *15 Mbps and Above* has least scored in subscription.

4.2.8 INTERNET CONNECTION TYPE

Table 4.17: Internet Connection Type

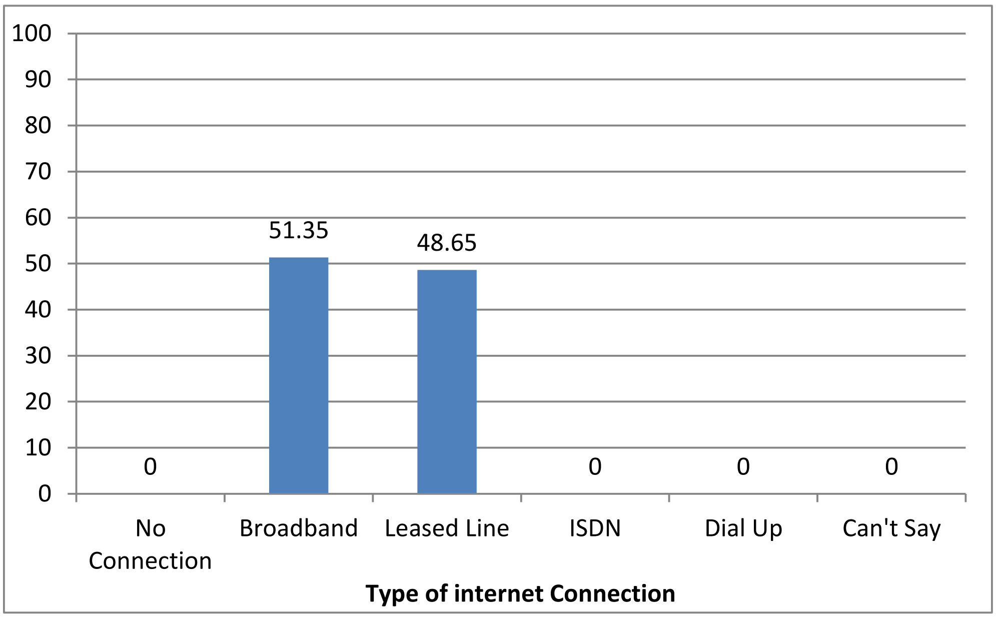
Responses of Technical Staff						
No Connection	**Broadband**	**Leased Line**	**ISDN**	**Dial-Up**	**Can't Say**	**Total**
0 (0)	57 (51.4)	54 (48.6)	0 (0)	0 (0)	0 (0)	111 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.17depicts the *Internet Connection Type* being used by used by Higher Technical Education Institutions in Pune region as per responses of Technical Staff and Head of Institute. Responses (valid) were taken from 111 Technical Staff. Responses were specifically taken from this category of respondents taking in mind that they are the best people who have the exact technical details for this type of question. The purpose was to find which the Internet Connection Type was being subscribed and used by Technical Higher Education Institutions in Pune region.

As the Table 4.17 depicts, Broadband(51.4%) tops the list as most commonly used followed by Leased-line (48.6%). Other traditional types of connections like ISDN and Dial-Up are not at all being used.

Graph 4.6: Internet Connection Type



Graph 4.6 illustrates the trends in Internet Connection Type being used by Institutions providing Higher Technical Education. As is evident from the graph, it is the *BroadBand* (51.35%) and *Leased Line* (48.65%) which are the most commonly used Internet Connection Types.

SUMMARY:

Internet Connection type comes under the category of basic I.C.T. infrastructure facility as per rules and regulations laid down by various Higher education Regulatory Authorities with respect to Higher Technical Education. What we can conclude from here is that in the contemporary world, Broadband(51.35%) and Leasedline (48.65%) internet connections are most common in use. Various factors for this include ease of installation and use, pricing, etc. ISDN and Dial-up are not preferred may be due to less speed and higher set-up and running costs.

4.2.9 PURPOSE OF USE OF I.C.T. INFRASTRUCTURE IN INSTITUTIONS

Table 4.18: Purpose of Use of I.C.T. Infrastructure w.r.t. Technical Staff

Item	Responses of Technical Staff							
	Never (1)	Some times (2)	Can't Say (3)	Frequently (4)	Very Frequently (5)	Total	Wt. Avg	Rank
Email	0 (0)	1 (0.9)	0 (0)	38 (34.23)	72 (64.86)	111 (100)	4.63	1
Lecture Preparation	0 (0)	2 (1.8)	13 (11.71)	58 (52.25)	38 (34.23)	111 (100)	4.19	2
View online lectures	0 (0)	4 (3.6)	12 (10.81)	81 (72.97)	14 (12.61)	111 (100)	3.95	3
Lecture delivery / Practical session	0 (0)	20 (18.02)	8 (7.21)	59 (53.15)	24 (21.62)	111 (100)	3.78	4
Research work	0 (0)	9 (8.11)	20 (18.02)	70 (63.06)	12 (10.81)	111 (100)	3.77	5
Social Networking	3 (2.7)	27 (24.32)	9 (8.11)	42 (37.84)	30 (27.03)	111 (100)	3.62	6
Administrati ve work	0 (0)	4 (3.6)	46 (41.44)	49 (44.14)	12 (10.81)	111 (100)	3.62	7
Exam work	0 (0)	24 (21.62)	3 (2.7)	78 (70.27)	6 (5.41)	111 (100)	3.59	8
Newspaper reading	6 (5.41)	40 (36.04)	27 (24.32)	38 (34.23)	0 (0)	111 (100)	2.87	9
Others	19 (17.12)	1 (0.9)	84 (75.68)	7 (6.31)	0 (0)	111 (100)	2.71	10
Listening to songs and videos	22 (19.82)	46 (41.44)	5 (4.5)	36 (32.43)	2 (1.8)	111 (100)	2.55	11
Job searching	33 (29.73)	22 (19.82)	24 (21.62)	32 (28.83)	0 (0)	111 (100)	2.5	12

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.18 depicts the trends in the *Purpose of Use of I.C.T. Infrastructure*as per responses of Technical Staff. 111 responses were taken from this category of Respondents. The purpose was to find patterns of usage of I.C.T.

infrastructureprovided by Technical Higher Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure usages (e-mail, job searching, etc.) based on Weighted Average calculated for each of these items.

As per Technical Staff Respondent's views (Refer Table 4.18), *Emails* have been Ranked at No. 1 followed by *Lecture Preparation* (Rank 2), and *View Online lectures*(Rank 3). This implies that most of the users and they themselves mostly use their institutions I.C.T. infrastructure for Email. Job Searching (Rank 12) at last which means users do not search for Jobs using their institutions I.C.T. infrastructure.

Deeper analysis shows that 99.1% Technical Staff respondents say that *Email* is Frequently used which is followed by *Lecture Preparation*(86.5%). In contract to this, 61.3% respondents say that *Listening to songs and Videos*and *Job searching* (49.5%) is not done by the users using the institution's I.C.T. infrastructure.

Table 4.19: Purpose of Use of I.C.T. Infrastructure w.r.t. Full-Time Teaching Staff

Item	Responses of Full-Time Teaching Faculty Staff							
	Never (1)	Some times (2)	Can't Say (3)	Frequently (4)	Very frequently (5)	Total	Wtd Avg.	Rank
Research work	3 (0.9)	11 (3.31)	13 (3.92)	109 (32.83)	196 (59.04)	332 (100)	4.46	1
Email	0 (0)	45 (13.55)	0(0)	71 (21.39)	216 (65.06)	332 (100)	4.38	2
Lecture preparation	0 (0)	59 (17.77)	3 (0.9)	116 (34.94)	154 (46.39)	332 (100)	4.1	3
Administrative work	1 (0.3)	72 (21.69)	20 (6.02)	53 (15.96)	186 (56.02)	332 (100)	4.06	4
View online lectures	1 (0.3)	70 (21.08)	7 (2.11)	104 (31.33)	150 (45.18)	332 (100)	4	5
Lecture delivery / Practical session	2(0.6)	75 (22.59)	7 (2.11)	197 (59.34)	51 (15.36)	332 (100)	3.65	6
Exam work	0(0)	116 (34.94)	10 (3.01)	79 (23.8)	127 (38.25)	332 (100)	3.65	7
Social Networking	23 (6.93)	154 (46.39)	21 (6.33)	101 (30.42)	33 (9.94)	332 (100)	2.9	8
Others	3 (0.9)	83 (25)	212 (63.86)	18 (5.42)	16 (4.82)	332 (100)	2.88	9
Newspaper reading	12 (3.61)	239 (71.99)	16 (4.82)	40 (12.05)	25 (7.53)	332 (100)	2.48	10
Job searching	51 (15.36)	179 (53.92)	79 (23.8)	13 (3.92)	10 (3.01)	332 (100)	2.25	11
Listening to songs and videos	94 (28.31)	127 (38.25)	85 (25.6)	9 (2.71)	17 (5.12)	332 (100)	2.18	12

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.19 depicts the trends in the *Purpose of Use of I.C.T. Infrastructure* as per responses of Full-Time Teaching Faculty Staff. 332 responses were taken from this category of Respondents. The purpose was to find patterns of usage of I.C.T. infrastructure provided by Higher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure usages (e-mail, job searching, etc.) based on Weighted Average calculated for each of these items.

As per Full-time Teaching Staff Respondent's views (Refer Table 4.19), *Research work* has Ranked at No. 1 followed by *Email*(Rank 2), and *Lecture Preparation*(Rank 3). This implies that Teaching Staff uses their institution's I.C.T. infrastructure most frequently for research purpose followed by Email which we could presume that is being used for business-related emailing. *Listening to songs and videos*(Rank 12) comes at last which means teaching staff doesn't spend much time on leisure.

Further analysis shows that 91.87% Teaching Staff respondents use *Research work* Frequently which is followed by *Email* (86.45%). In contract to this, 66.57% respondents state that they don't use institution's I.C.T. infrastructure for *Listening to songs and videos*. Another 69.28% respondents say that they don't use it for *Job searching.*

Table 4.20: Purpose of Use of I.C.T. Infrastructure w.r.t. Full-Time Students

Item	Responses of Full-Time Students							
	Never (1)	Some times (2)	Can't Say (3)	Frequently (4)	Very frequently (5)	Total	Wtd Avg.	Rank
Email	0 (0)	18 (4.14)	25 (5.75)	115 (26.44)	277 (63.68)	435 (100)	4.50	1
Lecture and practical sessions	1 (0.23)	21 (4.83)	68 (15.63)	136 (31.26)	209 (48.05)	435 (100)	4.22	2
Social Networking	30 (6.9)	26 (5.98)	43 (9.89)	108 (24.83)	228 (52.41)	435 (100)	4.1	3
Research work	37 (8.51)	40 (9.2)	40 (9.2)	226 (51.95)	92 (21.15)	435 (100)	3.68	4
Exam work	3 (0.69)	142 (32.64)	81 (18.62)	181 (41.61)	28 (6.44)	435 (100)	3.2	5
Job searching	92 (21.15)	104 (23.91)	18 (4.14)	200 (45.98)	21 (4.83)	435 (100)	2.89	6
Listening to songs and videos	70 (16.09)	194 (44.6)	24 (5.52)	16 (3.68)	131 (30.11)	435 (100)	2.87	7
Newspaper reading	103 (23.68)	100 (22.99)	49 (11.26)	126 (28.97)	57 (13.1)	435 (100)	2.85	8
Beyond syllabus learning	7 (1.61)	248 (57.01)	95 (21.84)	71 (16.32)	14 (3.22)	435 (100)	2.63	9
Others	41 (9.43)	188 (43.22)	188 (43.22)	12 (2.76)	6 (1.38)	435 (100)	2.43	10
View online lectures	205 (47.13)	68 (15.63)	17 (3.91)	121 (27.82)	24 (5.52)	435 (100)	2.29	11
Vocational Training	25 (5.75)	344 (79.08)	37 (8.51)	17 (3.91)	12 (2.76)	435 (100)	2.19	12

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.20 depicts the trends in the *Purpose of Use of I.C.T. Infrastructure* as per responses of Full-Time Students. 435 responses were taken from this category of Respondents. The purpose was to find patterns of usage of I.C.T. infrastructure provided by Higher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Never, Sometimes, Can't Say, Frequently and Very Frequently were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure usages (e-mail, job searching, etc.) based on Weighted Average calculated for each of these items.

As per Full-Time Students Respondent's views (Refer Table 4.20), *Email*has Ranked at No. 1 followed by *Lecture and practical sessions* (Rank 2), and *Social Networking*(Rank 3). This implies that Full-Time Students use their institution's I.C.T. infrastructure most frequently for Emailing(which might be for personal or to receive official communications from institute) followed by *Lecture and practical sessions*. Social Networking appearing at number 3 shows that students are quite frequent in leisure work. *View Online Lectures* and *Vocational Training* appear at 11^{th} and 12^{th} Ranks respectively which means Students don't use I.C.T. infrastructure for academic purposes or for self-development.

Further analysis shows that 90.11% Student respondents use *Email*Frequently which is followed by *Lecture and practical sessions*(79.31%) and *Social Networking* (77.24%). Majority students state that they don't use I.C.T. infrastructure of their institution for View online lectures (62.76% not frequently used) Vocational Training (84.83% not frequently used).

Table 4.21: Purpose of Use of I.C.T. Infrastructure (Integrated)

Item	Ranks	Item	Rank	
	Full-Time Students		**Technical Staff**	**Full-time Teaching Staff**
1.Email	1	1.Email	1	2
2. Social Networking	3	2. Social Networking	6	8
3. Newspaper reading	8	3. Newspaper reading	9	10
4. Job searching	6	4. Job searching	12	11
5. Listening to songs and videos	7	5. Listening to songs and videos	11	12
6. Lecture and practical sessions	2	6. Lecture preparation	2	3
7. View online lectures	11	7. View online lectures	3	5
8.Research work	4	8.Research work	5	1
9. Vocational Training	12	9. Administrative work	7	4
10. Exam work	5	10. Exam work	8	7
11. Beyond syllabus learning	9	11. Lecture delivery / Practical session	4	6
12. Others	10	12. Others	10	9

As is evident from **Table 4.21, t**he ranking by Teaching staff and teaching staff for most items is similar though not same for most items. For example Email where the ranking is 2 and 1 respectively. This means that the preference of purpose of use of I.C.T. infrastructure is quite common between these two respondent types. But when we compare these responses with Student responses their Reponses show depict a variation in certain purpose of use. E.g. *Listening to songs and videos.*

SUMMARY:

While Teaching Staff's usage pattern depicts their inclination towards usage of I.C.T. infrastructure for academic purpose, the Student's usage pattern depicts that students are more inclined towards entertainment and socializing and that academics is their second preference w.r.t. using their institute's I.C.T. infrastructure.

As per Technical Staff, *Emails* (99.1% frequently used) have been Ranked at No. 1 followed by *Lecture Preparation* (Rank 2; 86.5% frequently used), and *View Online lectures* (Rank 3). This implies that most of the users and technical staff themselves use their institutions I.C.T. infrastructure for Email. In contract to this, 61.3% respondents say that *Listening to songs and Videos* and *Job searching* (49.5%) is not done by the users using the institution's I.C.T. infrastructure.

As per Full-time Teaching Staff Respondent's views, *Research work* (91.87% Frequently used) has Ranked at No. 1 followed by *Email* (Rank 2; 86.45% frequently used), and *Lecture Preparation* (Rank 3). This implies that Teaching Staff uses their institution's I.C.T. infrastructure most frequently for research purpose followed by Email which we could presume that is being used for business-related emailing. In contract to this, 66.57% respondents state that they don't use institution's I.C.T. infrastructure for *Listening to songs and videos*. Another 69.28% respondents say that they don't use it for *Job searching.* These come at the bottom of the list.

As per Full-Time Students Respondent's views, *Email* (90.11% frequently used) has Ranked at No. 1 followed by *Lecture and practical sessions* (Rank 2; 79.31% frequently used), and *Social Networking*(Rank 3;77.24% frequently used). This implies that Full-Time Students use their institution's I.C.T. infrastructure most frequently for Emailing (which might be for personal or to receive official communications from institute) followed by *Lecture and practical sessions*. Social Networking appearing at number 3 shows that students are quite frequent in leisure work. *View Online Lectures* and *Vocational Training* appear at 11^{th} and 12^{th} Ranks respectively which means Students don't use I.C.T. infrastructure for academic purposes or for self-development. Majority students state that they don't use I.C.T. infrastructure of their institution for View online lectures (62.76% not frequently used) Vocational Training (84.83% not frequently used).

4.2.10 INSTITUTION CONNECTED TO ERNET

Table 4.22: Institution Connected to ERNET

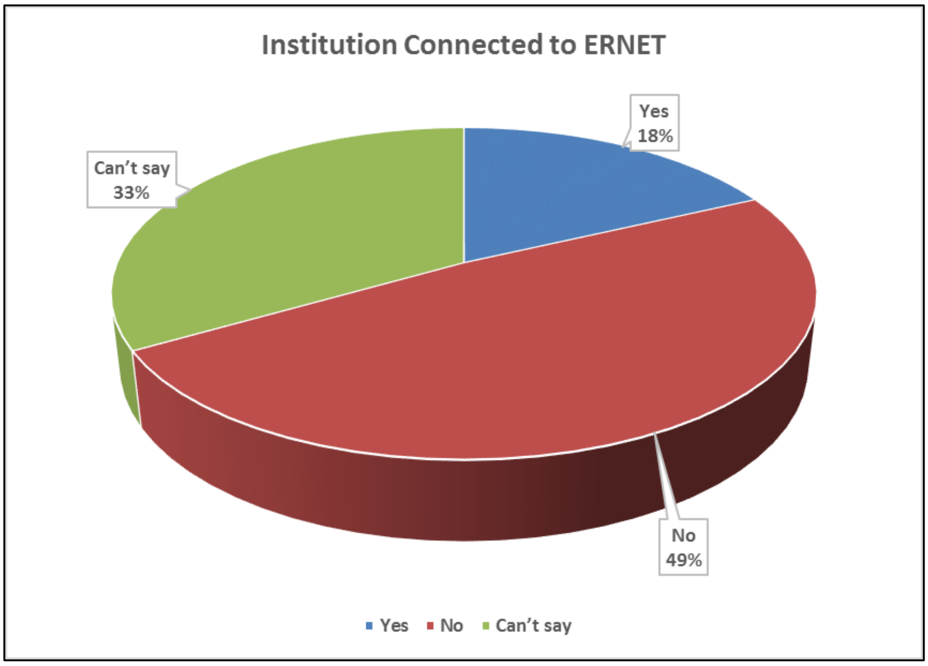
Yes	No	Can't say	Total
20 (18)	54 (48.6)	37 (33.3)	111 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.22 depicts the trend of Technical Higher Education Institutions in Pune region being connected to ERNET as per responses of Technical Staff. Responses were taken from 111 Technical Staff. Responses were specifically taken from this category of respondents taking in mind that they are the best people who have the exact technical details for this type of question.

As the Table 4.22 depicts, 18% of respondents say that their institution is connected to ERNET while 48.6% respondents say that their institution is not connected to ERNET.

Graph 4.7: Institution Connected to ERNET



Graph 4.7 illustrates that 18% of respondents say that their institution is *Connected to ERNET* while 48.6% respondents say that their institution is *Not connected to ERNET*. It is important to note that 33.33% respondents say that they can't say whether their institute is connected or not.

SUMMARY:

Through respondent's responses it is clear that majority of institutions are Not Connected with ERNET (48.6%). One reason for this is that ERNET is not available to private educational institutions. That is also the reason why a lot of Technical Staff respondents are not aware of its existence.

4.2.11 AVAILABILITY OF WI-FI IN INSTITUTION

Table 4.23: Availability of Wi-Fi in Institution

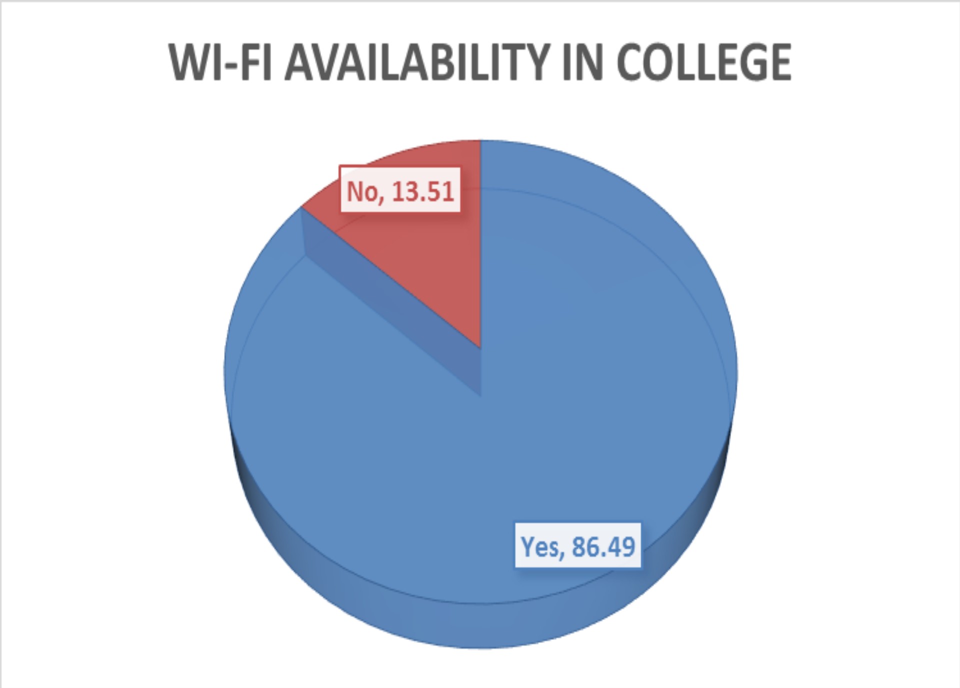
Yes	No	Total
96 (86.49)	15 (13.51)	111 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.23depicts the trends regarding *Whether Wi-Fi Network is installed* in Technical Higher Education Institutions in Pune region as per responses of Technical Staff. Responses were taken from 111 Technical Staff. Responses were specifically taken from this category of respondents taking in mind that they are the best people who have the exact technical details for this type of question. The purpose was to find whether Wi-Fi is installed in Higher Technical Education Institutions in Pune region.

As the Table 4.23 depicts, 86.49% respondents say that their institution has Wi-Fi network installed while 13.51% respondents say that their institution doesn't have Wi-Fi network installed.

Graph 4.8: Availability of Wi-Fi in Institution



Graph 4.8illustrates the trends regarding *Whether Wi-Fi Network is installed* in Higher Technical Education Institutions in Pune region as per responses of Technical Staff. As is evident from the graph, As the Graph 4.7 depicts, 86.49% respondents say that their institution has Wi-Fi network installed in their campus while 86.19% respondents say that their institution doesn't have Wi-Fi network installed.

SUMMARY:

86.49% respondents say that their institution has Wi-Fi network installed while 13.51% respondents say that their institution doesn't have Wi-Fi network installed.

Wi-FiNetwork type today comes under the category of basic I.C.T. infrastructure as per rules and regulations laid down by various Higher education Regulatory Authorities with respect to Higher Technical Education. What we can conclude from here is that in the Wi-Fi network is generally available in majority ofHigher Technical Education institutions.

4.3 TO STUDY USER SATISFACTION WITH REGARDS TO I.C.T. FACILITIES AND SERVICES PROVIDED BY INSTITUTIONS.

4.3.1 SATISFACTION AMONG USERS W.R.T. SELECT I.C.T. SERVICES PROVIDED BY INSTITUTION

Table 4.24: Satisfaction among users as per Technical Staff

I.C.T. Services	Responses of Technical Staff							
	Strongly Dissatisfied (1)	Dissatisfied (2)	Can't Say (3)	Satisfied (4)	Strongly Satisfied (5)	Total	Weighted Avg	Rank
Internet services through wired network	0 (0)	2 (1.8)	15 (13.51)	26 (23.42)	68 (61.26)	111 (100)	4.44	1
Maintenance / Technical support	0 (0)	4(3.6)	10 (9.01)	55 (49.55)	42 (37.84)	111 (100)	4.22	2
Communication facilities (email, SMS, alert messaging, etc.)	0 (0)	0 (0)	5 (4.5)	78 (70.27)	28 (25.23)	111 (100)	4.21	3
Internet services through Wi-Fi	0 (0)	5 (4.5)	8 (7.21)	69 (62.16)	29 (26.13)	111 (100)	4.1	4
I.C.T. Security policies and Security facility	0 (0)	7 (6.31)	23 (20.72)	56 (50.45)	25 (22.52)	111 (100)	3.89	5
Academic application software	0 (0)	9 (8.11)	33 (29.73)	51 (45.95)	18 (16.22)	111 (100)	3.7	6
Administration software	0 (0)	6 (5.41)	57 (51.35)	35 (31.53)	13 (11.71)	111 (100)	3.5	7
Storage and Backup utilities	10 (9.01)	16 (14.41)	36 (32.43)	47 (42.34)	2 (1.8)	111 (100)	3.14	8

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.24 depicts the trends in the *Satisfaction among users regarding I.C.T. infrastructure* provided by their instituteas per responses of Technical Staff. 111 responses were taken from this category of Respondents. The purpose was to find satisfaction levels among users regarding various services provided by HigherTechnical Education Institutions in Pune region. Likert's 5-point scale having the following options of Strongly Dissatisfied, Dissatisfied, Can't Say, Satisfied and Very Strongly Satisfied were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure services (Administration software, Maintenance / Technical support, etc.) based on Weighted Average calculated for each of these items.

As per Technical Staff Respondent's views (Refer Table 4.24), *Internet services through wired network* has Ranked at No. 1 (84.68% Satisfied) followed by *Maintenance / Technical support*(Rank 2; 87.39% Satisfied), and *Communication facilities (email, SMS, alert messaging, etc.)*(Rank 3; 95.5% Satisfied) and show weighted averages that correspond to *Satisfied*. Administration software, Storage and Backup utilities Rank at 7th and 8th. Of these, *Storage and Backup Utilities* show weighted averages corresponding to Can't Say.

Further analysis shows that in case of *Storage and Backup utilities* the number of respondents who are *satisfied* (44.14%) far exceeds the number of respondents that are dissatisfied (23.42%). This implies that still nearly 55% respondents are either not satisfied or have refrained from giving a suitable response. Thus, there is a big scope of improvement in this area.

Table 4.25: Satisfaction among users as per Full-Time Teaching Staff

I.C.T. Services	Responses of Full-Time Faculty Teaching Members							
	Strongly Dissatisfied (1)	Dissatisfied (2)	Can't Say (3)	Satisfied (4)	Strongly Satisfied (5)	Total	Weighted Avg	Rank
Communication facilities (email, SMS, alert messaging, etc.)	1 (0.3)	0 (0)	81 (24.4)	50 (15.06)	200 (60.24)	332 (100)	4.35	1
Internet services through Wired network	1 (0.3)	7 (2.11)	19 (5.72)	187 (56.33)	118 (35.54)	332 (100)	4.25	2
Maintenance / Technical support	0 (0)	4 (1.2)	49 (14.76)	230 (69.28)	49 (14.76)	332 (100)	3.98	3
Administration software	0(0)	6 (1.81)	38 (11.45)	266 (80.12)	22 (6.63)	332 (100)	3.92	4
Academic application software	1 (0.3)	5 (1.51)	61 (18.37)	238 (71.69)	27 (8.13)	332 (100)	3.86	5
Internet services through Wi-Fi	6 (1.81)	28 (8.43)	104 (31.33)	173 (52.11)	21 (6.33)	332 (100)	3.35	6
I.C.T. Security policies and Security facility	2 (0.6)	8 (2.41)	242 (72.89)	64 (19.28)	16 (4.82)	332 (100)	3.25	7
Storage and Backup utilities	7 (2.11)	115 (34.64)	122 (36.75)	73 (21.99)	15 (4.52)	332 (100)	2.92	8

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.25 depicts the trends in the *Satisfaction among users regarding I.C.T. infrastructure* provided by their institute as per responses of Full-Time Faculty

Teaching Members. 332 responses were taken from this category of Respondents. The purpose was to find satisfaction levels among users regarding various services provided by Higher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Strongly Dissatisfied, Dissatisfied, Can't say, Satisfied and Very Strongly Satisfied were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure services (Administration software, Maintenance / Technical support, etc.) based on Weighted Average calculated for each of these items.

As per Full-Time Faculty Teaching Members Respondent's views (Refer Table 4.25), *Communication facilities (email, SMS, alert messaging, etc.)*has Ranked at No. 1 (75.3% Satisfied) followed by *Internet services through wired network*(Rank 2; 91.87% Satisfied), and *Maintenance / Technical support* (Rank 3; 84.04% Satisfied) and show weighted averages that correspond to *Satisfied*. *I.C.T. Security policies*(9.34% Satisfied,& 72.89% Can't Say, 3.01% Dissatisfied) and *Storage and Backup utilities*(36.75% Dissatisfied, 36.75% Can't Say &26.51% Satisfied)Rank at 7thand 8thand show weighted averages corresponding to Can't Say.

Further analysis shows that in case of *I.C.T. Security policies* the number of respondents who are *satisfied* (24.10%) far exceeds the number of respondents that are dissatisfied (3.01%). This implies that respondents are actually satisfied with it. But in case of *Storage and Backup utilities policies* the number of respondents who are *satisfied* (26.51%) is far less than the number of respondents that are *dissatisfied* (36.75%) which implies that respondents are not satisfied with it.

Table 4.26: Satisfaction among users as per Full-Time Students

I.C.T. Services	Responses of Full-Time Students							
	Strongly Dissatisfied (1)	Dissatisfied (2)	Can't Say (3)	Satisfied (4)	Strongly Satisfied (5)	Total	Weighted Avg	Rank
Communication facilities (email, SMS, alert messaging, etc.)	1 (0.2)	9 (2.1)	57 (13.1)	192 (44.1)	176 (40.5)	435 (100)	4.23	1
Internet services through wired network	39 (9)	13 (3)	110(25.3)	234 (53.8)	39 (9.0)	435 (100.1)	3.51	2
Academic application software	1 (0.2)	60 (13.8)	111 (25.5)	254 (58.4)	9 (2.1)	435 (100)	3.48	3
Internet services through Wi-Fi	57 (13.1)	147 (33.8)	29 (6.7)	198 (45.5)	4 (0.9)	435 (100)	3.48	4
Maintenance / Technical support	51 (11.7)	131 (30.1)	88 (20.2)	153 (35.2)	12 (2.8)	435 (100)	2.87	5
I.C.T. Security policies and Security facility	51 (11.7)	41 (9.4)	290 (66.7)	47 (10.8)	6 (1.4)	435 (100)	2.87	6
Storage and Backup utilities	51 (11.7)	183 (42.1)	39 (9)	147 (33.8)	15 (3.4)	435 (100)	2.75	7
Administration software	49 (11.3)	132 (30.3)	217 (49.9)	34 (7.8)	3 (0.7)	435 (100)	2.56	8

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.26 depicts the trends in the *Satisfaction among users regarding I.C.T. infrastructure* provided by their instituteas per responses of Full-Time Students. 435 responses were taken from this category of Respondents. The purpose was to find satisfaction levels among users regarding various services provided by Higher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Strongly Dissatisfied, Dissatisfied, Can't say, Satisfied and Very Strongly Satisfied were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure services (Administration software, Maintenance / Technical support, etc.) based on Weighted Average calculated for each of these items.

As per Full-Time Student Respondent's views regarding satisfaction with certain I.C.T. services (Refer Table 4.26), *Communication facilities (email, SMS, alert messaging, etc.)* has Ranked at No. 1 (84.6% Satisfied) followed by *Internet services through wired network* (Rank 2; 62.8% Satisfied) and show weighted averages that correspond to Satisfied. *Academic application software*(Rank 3; 60.5% Satisfied) and *Internet services through Wi-Fi (*Rank 4; 46.9% Dissatisfied, 46.4% Satisfied*)* showweighted averages that correspond to Can't Say. *Storage and Backup utilities* and *Administration software* Rank at 7th and 8thalso show weighted averages corresponding to Can't Say.

Further analysis shows that in case of *Storage and Backup utilities*the number of respondents who are Dis*satisfied* (53.80%) far exceeds the number of respondents that are Satisfied (37.20%). This implies that respondents are actually Dissatisfied with it.

Similarly, in case of *Administration software*the number of respondents who are *satisfied* (8.50%) is far less than the number of respondents that are *dissatisfied* (41.60%) which implies that respondents are not satisfied with it.

Thus, improvements need to be made in Internet through Wi-Fi, Storage and Backup Utilities.

Table 4.27: Satisfaction trends among users (Integrated)

	Tech Staff			Teaching Staff			Student			Total(Weighted Avg * Frequency)	Total Respondents	Combined Avg.	Rank
	Weighted Avg	Frequency	Weighted Avg * Frequency	Weighted Avg	Frequency	Weighted Avg * Frequency	Weighted Avg	Frequency	Weighted Avg * Frequency				
Communication facilities (email, SMS, alert messaging, etc.)	4.21	111	467	4.35	332	1444	4.23	435	1838	3749	878	**4.27**	1
Internet services through wired network	4.44	111	493	4.25	332	1410	3.51	435	1526	3429	878	**3.91**	2
Academic application software	3.70	111	411	3.86	332	1281	3.48	435	1515	3207	878	**3.65**	3
Maintenance / Technical support	4.22	111	468	3.98	332	1320	2.87	435	1249	3037	878	**3.46**	4
Internet services through Wi-Fi	4.10	111	455	3.53	332	1171	2.87	435	1250	2876	878	**3.28**	5
Administration software	3.50	111	388	3.92	332	1300	2.56	435	1115	2803	878	**3.19**	6
I.C.T. Security policies and Security facility	3.89	111	432	3.25	332	1080	2.81	435	1221	2733	878	**3.11**	7
Storage and Backup utilities	3.14	111	348	2.92	332	970	2.75	435	1197	2515	878	**2.86**	8

As is evident from Table 4.27, *Communication facilities (email, SMS, alert messaging, etc.)* is Ranked **First** (4.27) w.r.t. Satisfaction trends among users. This is followed by *Internet services through wired network* (3.91) and *Academic application software* (3.65) at Second and Third Ranks respectively. All three of them show trends of Satisfied.

Storage and Backup utilities (2.86) ranks at Eighth position and end at the bottom of the list. This indicates that Institutions are lacking in having properly managed Data storage and Backup facilities. Academic and financial records are at the heart of an academic institution. As we are moving towards digitization and moving away from Paper-based record keeping, lack of data backup facilities can be catastrophic.

SUMMARY:

As per Technical Staff Respondent's views, *Internet services through wired network* has Ranked at No. 1 (84.68% Satisfied) followed by *Maintenance / Technical support* (Rank 2; 87.39% Satisfied), and *Communication facilities (email, SMS, alert messaging, etc.)*(Rank 3; 95.5% Satisfied). But *Administration software*, *Storage and Backup utilities* have come at the bottom of the list. Further analysis shows that in case of *Storage and Backup utilities* the number of respondents who are *satisfied* (44.14%) far exceeds the number of respondents that are dissatisfied (23.42%). This implies that still nearly 55% respondents are either not satisfied or have refrained from giving a suitable response. Thus, there is a big scope of improvement in this area.

As per Full-Time Faculty Teaching Members Respondent's views, *Communication facilities (email, SMS, alert messaging, etc.)* has Ranked at No. 1 (75.3% Satisfied) followed by *Internet services through wired network* (Rank 2; 91.87% Satisfied), and *Maintenance / Technical support* (Rank 3; 84.04% Satisfied). *I.C.T. Security policies* (9.34% Satisfied, & 72.89% Can't Say, 3.01% Dissatisfied) and *Storage and Backup utilities* (36.75% Dissatisfied, 36.75% Can't Say & 26.51% Satisfied) appear at the bottom of the list. There is a scope for huge amount improvements in these two areas.

As per Full-Time Student Respondent's, *Communication facilities (email, SMS, alert messaging, etc.)* has Ranked at No. 1 (84.6% Satisfied) followed by *Internet services through wired network* (Rank 2; 62.8% Satisfied).

Academic application software (Rank 3; 60.5% Satisfied) and *Internet services through Wi-Fi (*Rank 4; 46.9% Dissatisfied, 46.4% Satisfied*)*. In case of *Storage and Backup utilities* the number of respondents who are Dis*satisfied* (53.80%) far exceeds the number of respondents that are Satisfied (37.20%). This implies that respondents are actually Dissatisfied with it. Similarly, in case of *Administration software* the number of respondents who are *satisfied* (8.50%) is far less than the number of respondents that are *dissatisfied* (41.60%) which implies that respondents are not satisfied with it.

Thus, improvements need to be made in Internet through Wi-Fi, Storage and Backup Utilities.

But when we look at overall records, we find that *Communication facilities (email, SMS, alert messaging, etc.)* is Ranked **First** while *Storage and Backup utilities* comes at the bottom of the list. Academic and financial records are at the heart of an academic institution. As we are moving towards digitization and moving away from Paper-based record keeping, lack of data backup facilities can be catastrophic.

4.3.2 MEASURES TO IMPROVE USER SATISFACTION W.R.T. I.C.T. SERVICES PROVIDED BY INSTITUTION

Table 4.28: Measures to improve User Satisfaction w.r.t. I.C.T. Services provided by Institutions

Measures	Technical Staff Responses				Full-Time Teaching faculty Staff Responses				Full-Time Students			
	No	Can't Say	Yes	Total	No	Can't Say	Yes	Total	No	Can't Say	Yes	Total
(a) Training of Technical support staff	8 (7.2)	15 (13.5)	88 (79.3)	111 (100)	41 (12.3)	25 (7.5)	266 (80.1)	332 (100)	70 (16.1)	25 (5.7)	340 (78.2)	435 (100)
(b) Increase in number of technical support staff	2 (1.8)	12 (10.8)	97 (87.4)	111 (100)	24 (7.2)	31 (9.3)	277 (83.4)	332 (100)	47 (10.8)	105 (24.1)	283 (65.1)	435 (100)
(c) Replace old PCs, laptops, etc.	22 (19.8)	8 (7.2)	81 (73)	111 (100)	37 (11.1)	73 (22)	222 (66.9)	332 (100)	45 (10.3)	106 (24.4)	284 (65.3)	435 (100)
(d) Provide after-hour lab facility	40 (36)	51 (45.9)	20 (18)	111 (100)	32 (9.6)	61 (18.4)	239 (72)	332 (100)	26 (6)	169 (38.8)	240 (55.2)	435 (100)
(e) Leniency in access and content control on internet usage	57 (51.4)	31 (27.9)	23 (20.7)	111 (100)	24 (7.2)	35 (10.5)	273 (82.2)	332 (100)	9 (2.1)	102 (23.4)	324 (74.5)	435 (100)
(f) Increase Internet bandwidth and making available on all PCs	12 (10.8)	52 (46.8)	47 (42.3)	111 (100)	42 (12.7)	39 (11.7)	251 (75.6)	332 (100)	17 (3.9)	22 (5.1)	396 (91)	435 (100)
(g) Anti-virus	2 (1.8)	13 (11.7)	96 (86.5)	111 (100)	19 (5.7)	4 (1.2)	309 (93.1)	332 (100)	12 (2.7)	22 (5.1)	401 (92.2)	435 (100)
(h) ERP and other software used for teaching-learning	15 (13.5)	31 (27.9)	65 (58.6)	111 (100)	29 (8.7)	12 (3.6)	291 (87.7)	332 (100)	82 (18.9)	119 (27.4)	234 (53.7)	435 (100)
(i) More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students	18 (16.2)	62 (55.9)	31 (27.9)	111 (100)	26 (7.8)	31 (9.3)	275 (82.8)	332 (100)	42 (9.7)	212 (48.7)	181 (41.6)	435 (100)
(j) Any other	31 (27.9)	65 (58.6)	15 (13.5)	111 (100)	26 (7.8)	31 (9.3)	275 (82.8)	332 (100)	68 (15.6)	298 (68.5)	69 (15.9)	435 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.28 depicts the norms which have been followed by higher technical education institutions to create their I.C.T. infrastructure. Data has been collected from 111 Technical Staff, 332 Full-time teaching faculty Staff and 435 Full-Time Students.

Increase in number of technical support staff(87.4%) is most required whereas *Provide after-hour lab facility* (18%) is one of the least required for satisfaction enhancement as per Technical Staff.

Anti-virus(93.07%) is most required whereas *Replace old PCs, laptops, etc.*(66.68%) is least required as per Full-Time Teaching Staff.

Anti-virus (92.2%) is most required whereas *More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students*.(41.6%) is least required as per Full-Time Students. Under *Others*, Students have asked for *Free academic software for installation on their own personal PCs / laptops* which they need for student purpose

Graph 4.9 illustrate the areas which need to be addressed to improve User satisfaction regarding w.r.t. I.C.T. infrastructure and services offered by institutions of Higher Technical Education in Pune region.**Graph 4.9** depict YES responses respectively for each of the areas mentioned. Of the select areas mentioned in the list, Antivirus receives the highest YES responses followed by *Training of Technical Support Staff* and *Increase in number of Technical Support Staff*.

Graph 4.9: Measures to improve User Satisfaction w.r.t. I.C.T. Services

(YES responses only)

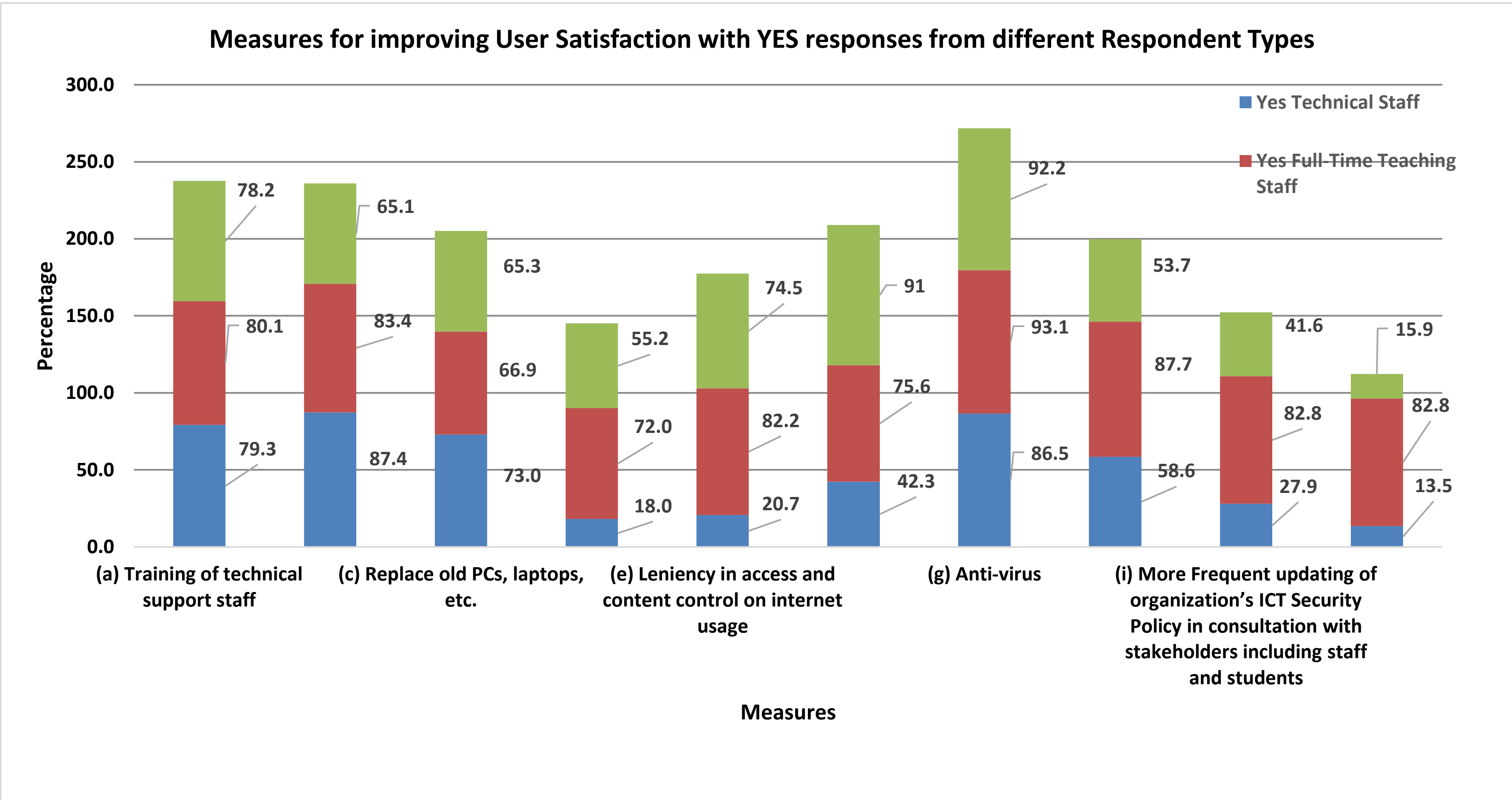


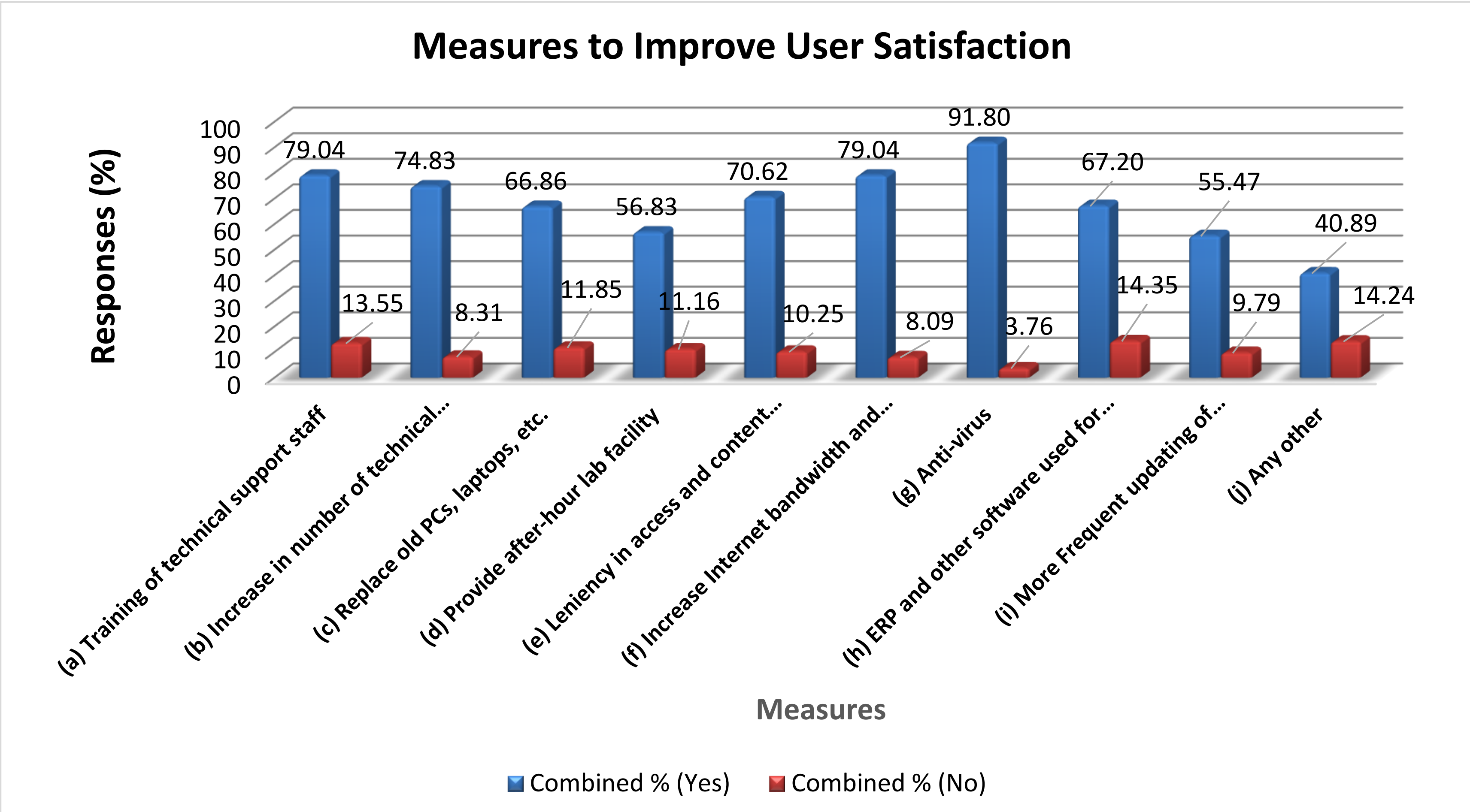
Table 4.29: Measures to improve User Satisfaction w.r.t. I.C.T. Services provided by Institutions (Integrated)

Measures	Yes Responses			No Responses		
	Total Responses	Respondents	Combined %	Total Responses	Respondents	Combined %
(a) Training of technical support staff	694	878	79.04	119	878	13.55
(b) Increase in number of technical support staff	657	878	74.83	73	878	8.31
(c) Replace old PCs, laptops, etc.	587	878	66.86	104	878	11.85
(d) Provide after-hour lab facility	499	878	56.83	98	878	11.16
(e) Leniency in access and content control on internet usage	620	878	70.62	90	878	10.25
(f) Increase Internet bandwidth and making available on all PCs	694	878	79.04	71	878	8.09
(g) Anti-virus	806	878	91.80	33	878	3.76
(h) ERP and other software used for teaching-learning	590	878	67.20	126	878	14.35
(i) More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students	487	878	55.47	86	878	9.79
(j) Any other	359	878	40.89	125	878	14.24

As is evident from **Table 4.29 and Graph 4.10**, the most highly desired measure as per all types of respondents is *Antivirus*(91.80%), *Training of technical support staff* (79.04%) and *Increase Internet bandwidth and making available on all PCs* (79.04%).

More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students (55.47%) is the least required improvement area desired by respondents collectively.

Graph 4.10: Measures to improve User Satisfaction w.r.t. I.C.T. Services (Integrated)



SUMMARY:

Increase in number of technical support staff (87.4%) is most required for satisfaction enhancement as per Technical Staff.*Anti-virus* (93.07%) is most required whereas *Replace old PCs, laptops, etc.* (66.68%) is least required as per Full-Time Teaching Staff.*Anti-virus* (92.2%) is most required whereas *More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students*.(41.6%) is least required as per Full-Time Students.

There is definitely a difference in opinions of different respondent types regarding what should be to improve user satisfaction. Anyhow, Antivirus has been a common factor that has come in majority of case at the top. Apart from this, *Increase in number of technical support staff* is another factor which features at the top.

Collectively, respondents want *Antivirus*(91.80%), *Training of technical support staff* (79.04%) and *Increase Internet bandwidth and making available on all PCs* (79.04%). major measures that will increase their satisfaction with regards to I.C.T. infrastructure and facilities provided in their higher technical educational institutions.

Few of the suggestions for improvement as prescribed by the respondents include 24*7 printing facility, printing facility in hostels, on-line academic document ordering and verification system, centralized I.C.T. technical desk helpline, college providing copy of academic software to use at home, etc. Students have asked for *Free academic software for installation on their own personal PCs / laptops* which they need for student purpose

4.4 TO IDENTIFY GAPS IN MANAGEMENT OF I.C.T. FACILITIES AND SERVICES AVAILABLE IN INSTITUTIONS WITH SPECIAL EMPHASIS ON I.C.T. SECURITY AND IDENTIFY SOLUTIONS FROM MANAGEMENT PERSPECTIVE IN ORDER TO RECEIVE ENVISAGED RESULTS.

4.4.1 EXTENT OF USER SATISFACTION W.R.T. OVERALL I.C.T. INFRASTRUCTURE SECURITY

Table 4.30: User Satisfaction w.r.t. overall I.C.T. infrastructure security

Responses	Respondent Type			
	Technical Staff	**Full-Time Teaching Staff**	**Full-Time Students**	**Head of Institute**
Strongly Dissatisfied (1)	0 (0)	1 (0.3)	12 (2.8)	0 (0)
Dissatisfied (2)	2 (1.8)	4 (1.2)	48 (11)	0 (0)
Can't Say (3)	7 (6.31)	56 (16.87)	36 (8.3)	0 (0)
Satisfied (4)	90 (81.08)	248 (74.7)	313 (72)	13 (34.2)
Strongly Satisfied (5)	12 (10.81)	23 (6.93)	26 (6)	25 (65.8)
Total	111 (100)	332 (100)	435 (100)	38 (100)
Weighted Avg.	4.01	3.87	3.67	4.66

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.30 depicts the trends in the *User Satisfied w.r.t. overall I.C.T. infrastructure security* provided by their instituteas per responses of Teaching Staff, Full-Time Faculty Teaching Members, Full-Time Students and Head of Institute. 111, 332,435 and 38 responses respectively were taken from these categories of Respondents. The purpose was to find *User Satisfied w.r.t. overall I.C.T. infrastructure security*among users inHigher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Strongly Dissatisfied, Dissatisfied, Can't say, Satisfied and Very Strongly Satisfied were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure services (Administration software, Maintenance / Technical support, etc.) based on Weighted Average calculated for each of these items.

Weighted averages from Technical Staff, Full-Time Faculty Teaching Members, Full-Time Students responses suggest that these respondents are Satisfied with overall I.C.T. security provided by their institution. Head of Institute'sresponses on the other hand show that they are Strongly Satisfied.

Further analysis reveals that Technical Staff (91.89%), Full-Time Faculty Teaching Members(81.62%), Full-Time Students (78%) and Head of Institute(100%) are satisfied with overall I.C.T. infrastructure security.

Table 4.31: User Satisfaction w.r.t. overall I.C.T. infrastructure security(Integrated)

Respondent Type	No. Of Respondents						Wt. Avg	Wt. Avg * Total Resp.	Combined Wt. Avg.
	Strongly Dissatisfied(1)	Dissatisfied(2)	Can't Say(3)	Satisfied(4)	Strongly Satisfied(5)	Total respondents			
Tech. Staff	0	2	7	90	12	111	4.01	445.11	3.82
Teaching	1	4	56	248	23	332	3.87	1284.84	
Student	12	48	36	313	26	435	3.67	1596.45	
Head of Institution	0	0	0	13	25	38	4.66	177.08	
Total						916		3503.48	

*Refer Table 4.30

Table 4.31 attempts to find the overall perception of all types of Respondents taken together. As is clear from the Table 4.26a, the combined Weighted Avg. for User Satisfied w.r.t. overall I.C.T. infrastructure security is 3.82. As this value falls near Satisfied (4), it can thus be inferred thatoverall the respondents are satisfied with the I.C.T. infrastructure security being maintained in Higher Technical Education in Pune region.

SUMMARY:

Whether we look at the responses of each individual respondent type separately or we see it in integrated manner, it is clear that the respondents are satisfied with the I.C.T. infrastructure security being maintained in Higher Technical Education in Pune region. But we must remember that I.C.T. security must be maintained at its peak i.e. responses should show Very Satisfied levels but this not so. Even slight lapse in security can compromise security of valuable data. Therefore, researcher infers that more need to be done to reach the Very Satisfied level.

4.4.2 EXTENT OF USER SATISFACTION W.R.T. OVERALL I.C.T. DIGITAL ASSETS SECURITY

Table 4.32: User Satisfaction w.r.t. overall I.C.T. Digital assets security

	Respondent Type	Technical Staff	Full-Time teaching Staff	Full-Time Students	Head of Institute
Responses	Strongly Dissatisfied (1)	1 (0.9)	0 (0)	14 (3.2)	0 (0)
	Dissatisfied (2)	7 (6.31)	6 (1.8)	62 (14.3)	0 (0)
	Can't Say (3)	15 (13.51)	76 (22.9)	301 (69.2)	2 (5.3)
	Satisfied (4)	83 (74.77)	236 (71.1)	50 (11.5)	15 (39.5)
	Strongly Satisfied (5)	5 (4.5)	14 (4.2)	8 (1.8)	21 (55.3)
	Total	111 (100)	332 (100)	435 (100)	38 (100)
	Weighted Avg.	3.76	3.78	2.94	4.5

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.32 depicts the trends in the User Satisfaction w.r.t. overall I.C.T. Digital assets security provided by their instituteas per responses of Teaching Staff, Full-Time Faculty Teaching Members, Full-Time Students and Head of Institute. 111, 332,435 and 38 responses respectively were taken from these categories of Respondents. The purpose was to find *User Satisfied w.r.t. overall I.C.T. Digital assets security* among users in Higher Technical Education Institutions in Pune region. Likert's 5-point scale having the following options of Strongly Dissatisfied, Dissatisfied, Can't say, Satisfied and Very Strongly Satisfied were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common I.C.T. infrastructure services (Administration software, Maintenance / Technical support, etc.) based on Weighted Average calculated for each of these items.

Weighted averages from Technical Staff, Full-Time Faculty Teaching Members responses suggest that these respondents are Satisfied with overall I.C.T.digital assets provided by their institution. Head of Institute's responses, on the other hand, show that they are Strongly Satisfied. Full-Time Students responses suggest that student respondents are not certain about their satisfaction w.r.t. overall I.C.T. security provided by their institution.

Further analysis reveals that 75.30% of teaching Staff and 94.74 of Head of Institute are satisfied. But 17.50% Students are dissatisfied whereas only 13.30% Students are satisfied with overall I.C.T. Digital assets security.

Table 4.33: User Satisfaction w.r.t. overall I.C.T. Digital assets security (Integrated)

Respondent Type	No. Of Respondents						Wt. Avg	Wt. Avg * Total Resp.	Combined Wt. Avg.
	Strongly Dissatisfied (1)	Dissatisfied (2)	Can't Say (3)	Satisfied(4)	Strongly Satisfied(5)	Total respondents			
ICT Technical Staff	1	7	15	83	5	111	3.76	417.36	3.41
Teaching Staff	0	6	76	236	14	332	3.78	1254.96	
Student	14	62	301	50	8	435	2.94	1278.9	
Head of Institution	0	0	2	15	21	38	4.5	171	
Total						916		3122.22	

*Refer Table 4.32

As is evident from **Table 4.33**, the overall of all respondents taken together reveals that the users have not given a very clear picture regarding whether they Satisfied or not. The value of Combined Weighted Average (3.41) is more inclined towards Can't Say. This means a lot needs to be done regarding I.C.T. digital asset security.

SUMMARY:

Individually, 75.30% of teaching Staff and 94.74 of Head of Institute are satisfied. But 17.50% Students are dissatisfied whereas only 13.30% Students are satisfied with overall I.C.T. Digital assets security. This means that majority of the teaching staff and Head of Institute are Satisfied with overall I.C.T. digital asset security. On the other hand, Students who are the end-users are actually dissatisfied. We must take in mind that the Students are in majority in the category of end-users and their dissatisfaction must be taken into consideration.

Overall responses of all respondents taken together reveals that the users have not given a very clear picture regarding whether they Satisfied or not. The value of Combined Weighted Average (3.41) is more inclined towards Can't Say.

It is possible that responses of Head of Institute or Teaching Staff could be biased as both are directly linked to I.C.T. security aspect as owners / service providers.

4.4.3 SEVERITY AND FREQUENCY OF I.C.T. SECURITY ATTACKS

Here, effort has been made to understand the severity and frequency of I.C.T. attacks that may be in higher technical management institutes.

In order to analyze the trends regarding the severity and frequency of attacks, data was collected from 3 respondent types viz. I.C.T. Technical Staff members, Full-Time teaching Staff and Head of Institute. On basis of Severity of I.C.T. security attacks, the attacks were classified into 3 categories viz. Low Intensity attacks, Mild intensity attacks, and High intensity attacks.

Respondents i.e. I.C.T. Technical Staff members, Full-Time teaching Staff and Head of Institute were then asked to Rate each one of them on basis of frequency of their occurrence as per their experience. Raking was done using a 5 point scale (1 to 5), where 1 indicates lowest frequency of occurrence while 5 indicates highest frequency of occurrence such that 1-Very low frequency of occurrence, moderately Low, 3- average, 4- moderately high, 5- Very highfrequency of occurrence. Weighted Averages were then used to analyze the data.

Analysis of data under this particular head has been carried out in 2 different ways:

(A) Respondent-Wise

(B) Intensity-wise

(A) Respondent-wise analysis

Table 4.34: Severity and Frequency of I.C.T. security attacks (Respondent-wise: Technical Staff)

Item	**Responses of Technical Staff: : FREQUENCY OF ATTACKS (1-Lowest frequency and 5- highest frequency)**						**Weighted Avg.**	**Rank**
	1	**2**	**3**	**4**	**5**	**Total**		
(a) Low intensity attacks(low operational, data and financial loss)	1 (0.9)	7 (6.31)	30 (27.03)	48 (43.24)	25 (22.52)	111 (100)	3.8	1
(b) Mild intensity attacks(mild operational, data and financial loss)	26 (23.42)	43 (38.74)	15 (13.51)	22 (19.82)	5 (4.5)	111 (100)	2.43	2
(c) High intensity attacks(high operational, data and financial loss)	53 (47.75)	32 (28.83)	16 (14.41)	6 (5.41)	4 (3.6)	111 (100)	1.88	3

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.34 depicts the responses of Technical Staff. The highest weighted Average is for Low intensity attacks (3.8) followed by Mild (2.43) and (1.88). This means that though mild and high attacks are also occurring but it is the Low Intensity attacks, which even though might not do lot of destruction or losses, but are most frequently occurring out of the three and their occurrence is nearly moderately high.

Table 4.35: Severity and Frequency of I.C.T. security attacks (Respondent-wise: Teaching Staff)

Item	Responses of Teaching Staff: : FREQUENCY OF ATTACKS (1-Lowest frequency and 5- highest frequency)					Total	Weighted Avg.	Rank
	1	2	3	4	5			
(a) Low intensity attacks (low operational, data and financial loss)	106 (31.93)	167 (50.3)	48 (14.46)	5 (1.51)	6 (1.81)	332 (100)	1.91	1
(b) Mild intensity attacks (mild operational, data and financial loss)	210 (63.25)	101 (30.42)	16 (4.82)	4 (1.2)	1 (0.3)	332 (100)	1.45	2
(c) High intensity attacks (high operational, data and financial loss)	233 (70.18)	81 (24.4)	14 (4.22)	4(1.2)	0(0)	332 (100)	1.36	3

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.35 depicts the responses of Teaching Staff. The highest weighted Average is for Low intensity attacks (1.91) followed by Mild (1.45) and (1.36). This means that though Low, mild and high attacks are also occurring buttheir frequently occurring is very low. Of the three it is the Low intensity attacks which is most occurring and is occurring at moderately low rate. Mild and High intensity attacks are occurring at nearly Low occurrence rates.Mild and High intensity attacks are occurring but at Low occurrence rates as compared to Low Intensity ones.

Table 4.36: Severity and Frequency of I.C.T. security attacks (Respondent-wise: Head of Institution)

Item	Responses of Head of Institution: : FREQUENCY OF ATTACKS (1-Lowest frequency and 5- highest frequency)						Weighted Avg.	Rank
	1	2	3	4	5	Total		
(a) Low intensity attacks(low operational, data and financial loss)	15 (39.47)	13 (34.21)	8 (21.05)	2 (5.26)	0 (0)	38 (100)	1.92	1
(b) Mild intensity attacks(mild operational, data and financial loss)	25 (65.79)	13 (34.21)	0 (0)	0 (0)	0 (0)	332 (100)	1.34	2
(c) High intensity attacks(high operational, data and financial loss)	36 (94.74)	2 (5.26)	0 (0)	0 (0)	0 (0)	38 (100)	1.05	3

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.36 depicts the responses of Heads of Institution. The highest weighted Average is for Low intensity attacks (1.92- Moderately low occurrence) followed by Mild (1.34- very low occurrence) and (1.05- very low occurrence). This means that though Low, mild and high attacks are also occurring but their frequently occurring is very low. Of the three it is the Low intensity attacks which is most occurring.

(B) Intensity-wise

Here we analyze the overall opinion of all respondents taken together with an aim to come to a conclude regarding which intensity of attack is most commonly occurring.

Table 4.37: Low Intensity attacks (Integrated)

Respondent Type	Low intensity attacks(low operational, data and financial loss) Responses (No. of Respondents)						Wt. Avg	Wt. Avg * Total Resp.	Combined Wt. Avg.
	1	2	3	4	5	Total			
Technical Staff	1	7	30	48	25	111	3.8	421.8	2.35
Faculty Staff	106	167	48	5	6	332	1.91	634.12	
Head of Institute	15	13	8	2	0	38	1.92	72.96	
Total						481		1128.88	

(Note: 1-Very low frequency, moderately Low, 3- average, 4- moderately high, 5- Very high occurrence)

Table 4.37 depicts the responses of all three types of respondents for Low Intensity attacks only. The Combined Weighted Average for Low Intensity (2.35) infers that Low intensity attacks haveModerately Low rate of occurrence on overall basis.

Table 4.38: Mild Intensity attacks (Integrated)

Respondent Type	Mild intensity attacks(Mild operational, data and financial loss) Responses (No. of Respondents)						Wt. Avg	Wt. Avg * Total Resp.	Combined Wt. Avg.
	1	2	3	4	5	Total			
Technical Staff	26	43	15	22	5	111	2.43	269.73	1.67
Faculty Staff	210	101	16	4	1	332	1.45	481.4	
Head of Institute	25	13	0	0	0	38	1.34	50.92	
Total						481		802.05	

(Note: 1-Very low frequency, moderately Low, 3- average, 4- moderately high, 5- Very high occurrence)

Table 4.38 depicts the responses of all three types of respondents for Mild Intensity attacks only. The Combined Weighted Average for Low Intensity (1.67) infers that Mild intensity attacks have Moderately Low rate of occurrence on overall basis.

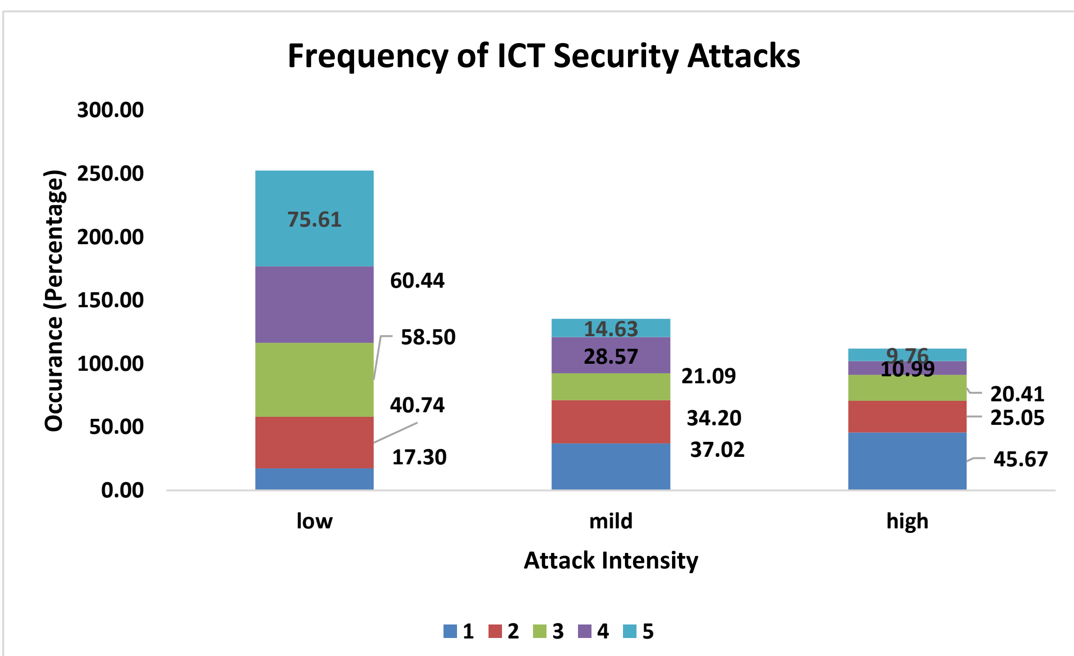
Table 4.39: High Intensity attacks (Integrated)

Respondent Type	High intensity attacks(High operational, data and financial loss) Responses (No. of Respondents)						Wt. Avg	Wt. Avg * Total Resp.	Combined Wt. Avg.
	1	2	3	4	5	Total			
Technical Staff	53	32	16	6	4	111	1.88	208.68	1.46
Faculty Staff	233	81	14	4	0	332	1.36	451.52	
Head of Institute	36	2	0	0	0	38	1.05	39.9	
Total						481		700.1	

(Note: 1-Very low frequency, moderately Low, 3- average, 4- moderately high, 5- Very high occurrence)

Table 4.39 depicts the responses of all three types of respondents for High Intensity attacks only. The Combined Weighted Average for Low Intensity (1.46) infers that High intensity attacks have Moderately Low rate of occurrence on overall basis.

Graph 4.11: Intensity and Frequency of I.C.T. security attacks (Integrated)



Graph 4.11 (Data Source Table 4.37, 4.38 & 4.39) depicts the overall view of the frequency of all 3 intensity of attacks viz. Low Intensity, Mild Intensity and High Intensity attacks. As is evident Low Intensity attacks are most common, followed by Mild Intensity attacks and High Intensity attacks.

Summary:

If we look at responses of all three types of respondents separately, we find all have opinioned that Low intensity attacks are the ones that have most frequently occurred as per their experience and knowledge. On overall basis, Low intensity attacks (2.35) are most frequently occurring and show characteristics of Average occurrence. Mild intensity attacks(1.67) as well as High intensity attacks (1.46) are having Moderately Low occurrences. Graph 4.11, which is a stacked graph showing responses of all three respondent types, also shows a similar trend.

As is evident from various studies, it has been found that lots of I.C.T. attacks that happen in higher educational institutions have students involved in it who either try to create attacks for fun or as a challenge, etc. This is a common trend in countries like USA but India is still lagging behind. We must understand that Indian students are still raw and lack technical skills but in future as the generations of students change and their technical skills are enhanced, these figures which are, as of now, for Low Intensity attacks might change into those for High Intensity attacks.

There is one more important fact that needs to be considered. Still there are lots of academic institutions in India who have not brought all their servers and data fully online that’s why hackers and attackers might have not have been attracted to attack them. But as they will be digitized High Intensity attacks may well occur there also.

4.4.4 RESPONDENT'S ROLE IN POLICY MAKING

Table 4.40: Respondent's Role in Policy Making

Respondent Type	No Role	Consultative	Lone Creator	Final decision maker	Total
Technical Staff	0 (0)	92 (82.9)	17 (15.3)	2 (1.8)	111 (100)
Head of Institute	0 (0)	6 (15.8)	3 (7.9)	29 (76.3)	38 (100)

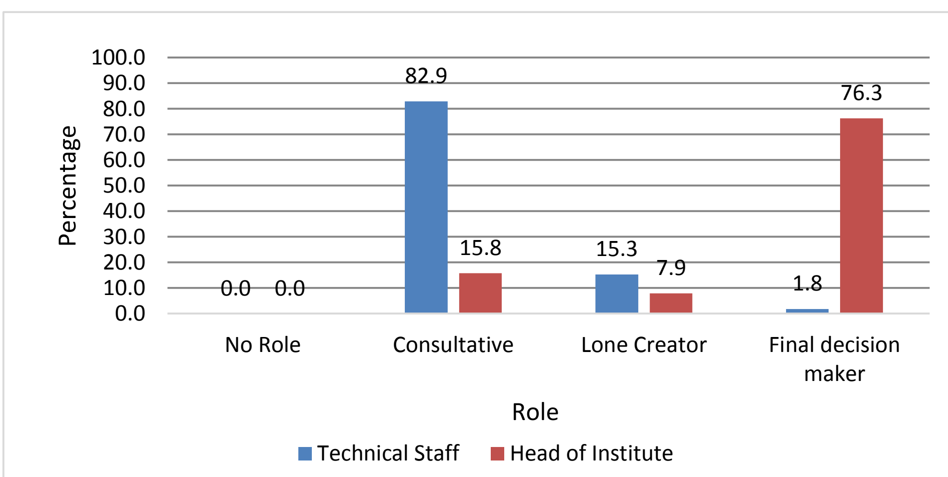
Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.40shows the trends in the type of role Technical Staff and Head of Institute's play in I.C.T. policy making. Responses were taken from Technical Staff (111 Nos.) and Head of Institute (38 Nos.).

As per Technical Staff's responses, we find that majority of these respondent's role in Policy Making is confined to *Consultative*(82.9%). This means that they mostly give consultation but they are not the final decision makers even though they have best technical and operational knowledge in this area.

Head of Institute's responses, on the other hand, depict that their role is majorly as *Final Decision Maker* (76.3%).

Graph 4.12: Respondent's Role in I.C.T. Policy Making



Graph 4.12(Data source Table 4.40) depicts the role of Technical Staff and Head of Institute in I.C.T. Policy making. As is evident from the graph, Technical Staff play more Consultative role while they are Final decision maker in very few cases. This means that they are just giving their advice to others in this regard.

SUMMARY:

It has been found that Technical Staff, even though they are at the operational level in I.C.T. infrastructure and maintenance, are not the Final Decision Makers w.r.t. I.C.T. policy making.There role has found to be *Consultative* (82.9%) even though they have best technical and operational knowledge in this area.

Head of Institute's responses, on the other hand, depict that their role is majorly as *Final Decision Maker* (76.3%). They may or may not take advice of Technical Staff. If they don't take advice then it can be treated as I.C.T. security gap as Head of Institute are not technical experts in the area of I.C.T. security.

4.4.5 PRESENCE OF FORMAL I.C.T. UP-GRADATION POLICY IN THE INSTITUTION

Table 4.41: Presence of formal I.C.T. Up-gradation Policy trends

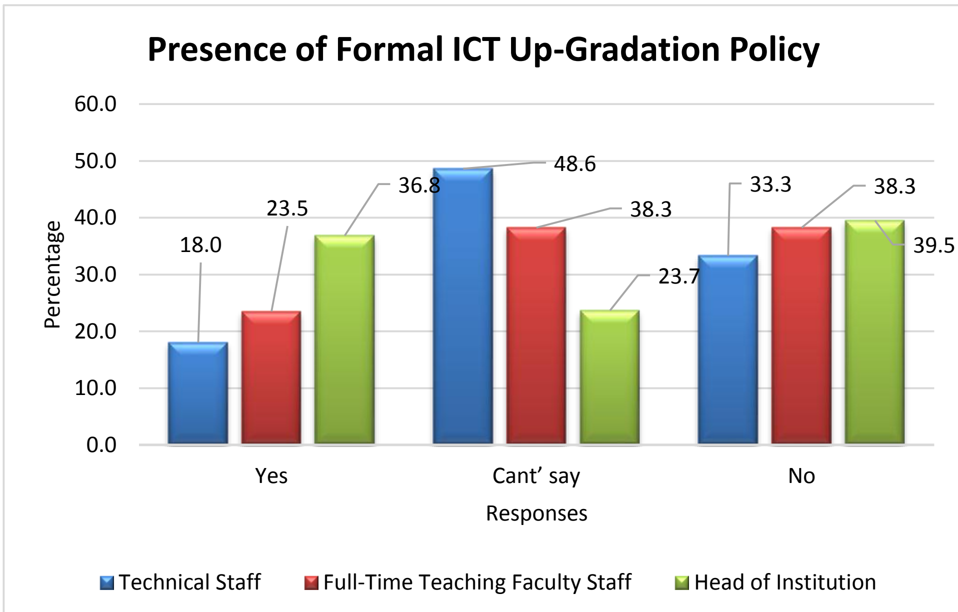
Respondent Type	Responses			
	Yes	Can't say	No	Total
Technical Staff	20 (18)	54 (48.6)	37 (33.3)	111 (100)
Full-Time Teaching Faculty Staff	78 (23.5)	127 (38.3)	127 (38.3)	332 (100)
Head of Institute	14 (36.8)	9 (23.7)	15 (39.5)	38 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.41shows the trends regarding presence of formal I.C.T. Up-gradation policy in Higher technical Education Institutions in Pune region as per responses of different respondent types. Responses were taken from Technical Staff (111 Nos.), Full-time Teaching Staff (332), and Head of Institute (38 Nos.).

As is evident from the table 4.41, Technical Staff (33.3%) state that their institute doesn't have a formal I.C.T. Up-gradation policy while only 18.0% say it is present. In case of Teaching staff, say 38.3% it is not present while only 23.5% say it is present. In case ofHead of Institute, 39.5% say it is not present while 36.8% say it is present in their institution.

Graph 4.13: Presence of Formal I.C.T. Up-Gradation Policy trends



Graph 4.13 (Data derived from Table 4.41**)**illustratestrends w.r.t. presence of formal I.C.T. Up-gradation policy in Higher Technical Education Institutions in Pune region. Responses were taken from 481 respondents including Technical Staff (111 Nos.), Full-time Teaching Staff (332), and Head of Institute (38 Nos.).

As depicted in Graph 4.13, majority of the respondent viz. Technical Staff (33.3%), Full-Time Teaching Staff (38.3%) and Head of Institute (39.5%) have claimed that their institution doesn't have a Formal I.C.T. Up-gradation policy.

Table 4.42: Presence of formal I.C.T. Up-gradation Policy trends (Integrated)

Respondent Type	Respondents (Frequency)			
	Yes	Can't say	No	Total
Technical Staff	20	54	37	111
Full-Time Teaching Faculty Staff	78	127	127	332
Head of Institute	14	9	15	38
Total	112	190	179	481
Percentage (%)	23.28	39.50	37.21	100

Table 4.42 (*Data derived from Table 4.41) strives to study on overall basis whether a Formal I.C.T. Up-gradation policy is present in Institutions of Higher Technical Education. As is evident from the table 4.31, overall, only 23.28% respondents have given a YES response where as 37.21% have given NO response. 39.50% have given Can't say responses and have, therefore, been omitted.

SUMMARY:

Technical Staff 18.0% state that their institute has a formal I.C.T. Up-gradation policy while only Teaching staff 23.5% say it is present. In case of Head of Institute, only 36.8% say it is present in their institution. Overall, only 23.28% respondents state that formal I.C.T. Up-gradation policy in the institution

This is an alarming state with regards to I.C.T. security scenario. This is because as new technology is coming up, new ways to create I.C.T. security attacks are coming up. If the institutions don't have formal up-gradation policy it means that they are not upgrading themselves win orderly manner and might fail to have enough technical capability and infrastructure to combat future possible I.C.T. security attacks. We can, thus, infer that due to lack of I.C.T. Up-gradation policy, the academic institution data in under high security threat on one hand, whereas on the other hand, Institutions are not providing quality I.C.T. infrastructure to their students who pay high amount of fee.

4.4.6 ANTIVIRUS INSTALLED ON SERVERS AND PCS

Table 4.43: Licensed Antivirus on Servers and PCs

Respondent Type	Percentage of Servers Antivirus is Installed			Percentage of PCs on which Antivirus is Installed		
	None	Few	All	None	Few	All
Technical Staff	4 (3.6)	48 (43.2)	59 (53.2)	0 (0)	77 (69.4)	34 (30.6)
Head of Institute	0 (0)	13 (34.2)	25 (65.8)	0 (0)	21 (55.3)	17 (44.7)

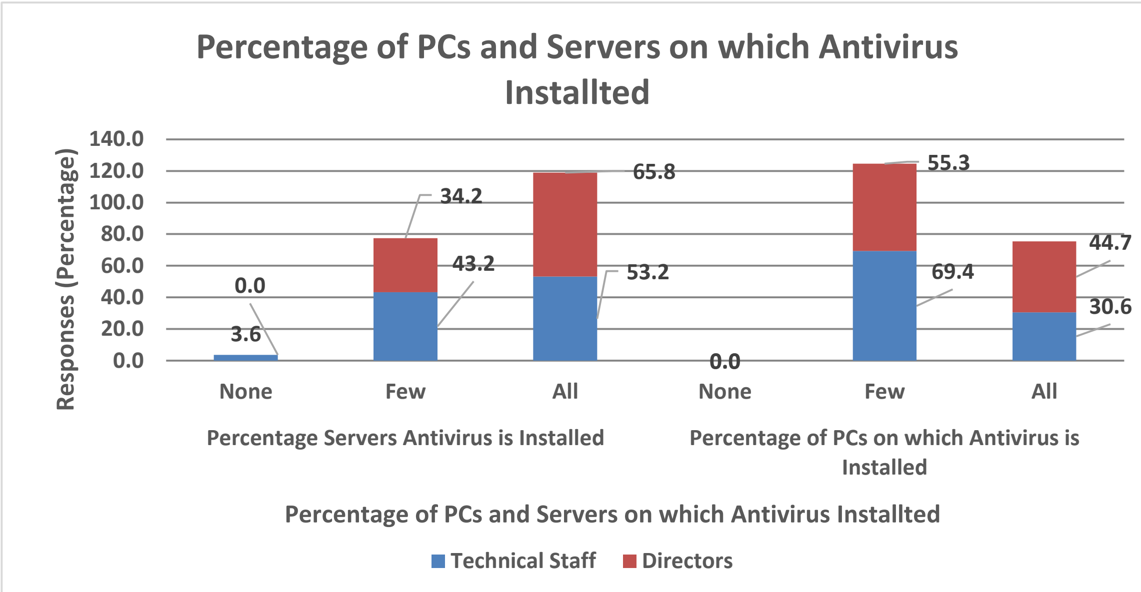
Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.43shows the responses of respondents regarding Percentage of PCs and Servers on which antivirus are installed in Higher Technical Education Institutions in Pune region. Responses were taken from Technical Staff (111 Nos.), and Head of Institute (38 Nos.). These respondent types were chosen for answering this particular question as they are the only respondents who exactly know the statistics on antivirus installation.

As is evident from the Table 4.43, we find that Technical Staff (53.2%) and Head of Institute (65.8%) state that *All Servers* have antivirus installed on them. Whereas Technical Staff (43.2%) and Head of Institute (34.2%) state that *Few Servers* have antivirus installed on them. This means that majority of servers are protected by antivirus.

On the other hand, we find that Technical Staff (30.6%) and Head of Institute (44.7%) state that *All PCs* have antivirus installed on them. Whereas Technical Staff (69.4%) and Head of Institute (55.3%) state that *Few PCs* have antivirus installed on them.

Graph 4.14: Licensed Antivirus on Servers and PCs



Graph 4.14 is a stacked column graph which illustrates an overall scenario w.r.t. percentage of PCs and Servers on which antivirus is installed in Higher Technical Education Institutions in Pune region. Responses were taken from Technical Staff (111 Nos.), and Head of Institute (38 Nos.).

As is evident from Graph 4.14, there are more cases where antivirus is installed on *All Servers* as compared to those installed on *All PCs*. On the contrary, there are more cases where antivirus are installed on *Few PCs* than *Few Servers*.

Table 4.15: Licensed Antivirus on Servers and PCs(Integrated)

Respondent Type	Responses (No. Of Respondents)							
	Number of Servers Antivirus is Installed				Number of PCs on which Antivirus is Installed			
	None	Few	All	Total	None	Few	All	Total
Technical Staff	4	48	59	111	0	77	34	111
Head of Institute	0	13	25	38	0	21	17	38
Total	4	61	84	149	0	98	51	149
Percentage	2.68	40.94	56.38		0.00	65.77	34.23	

*Data derived from Table 4.43

Table 4.44 is an attempt to depict and study whether Licensed Antivirus is installed on PCs and Servers. This table gives us an overall view derived from responses of all types of respondents taken together. In case of Servers, 56.38% respondents say it is installed on all Servers whereas 40.94% say it is installed on few servers in their technical higher educational institution. Though only 2.68% respondents say antivirus is not installed on any server, but here 40.94% (Installed on few Servers) is not a good trend as servers are the machines where majority data is stored or they provide vital network services and if they are not secured then it is a problem worth noting.

In case of PCs, 34.23% respondents have opined that antivirus is installed on All machines, but on the other hand 65.77% say that it is installed on Few machines. One of the biggest threats to data in academic institutions comes from students who work on public PCs available in computer labs of their academic institutions. Lack of antivirus on such public computers is very bad for the security of data in such institutions.

SUMMARY:

Antivirus on Servers: Technical Staff (53.2%) and Head of Institute (65.8%) state that *All Servers* have antivirus installed on them. Whereas Technical Staff (43.2%) and Head of Institute (34.2%) state that *Few Servers* have antivirus installed on them. Overall 40.94% respondents say that it is installed on *Few Servers*.This means that majority of Servers are protected by antivirus. But there exists a great opportunity on improvement here.

Antivirus on PCs: Technical Staff (30.6%) and Head of Institute (44.7%) state that *All PCs* have antivirus installed on them. Whereas Technical Staff (69.4%) and Head of Institute (55.3%) state that *Few PCs* have antivirus installed on them. Overall, 65.77% respondents have stated that antirirus has been installed on Few PCs. This means that majority of institutes don’t have antivirus installed on their 100% PCs. . This is a huge security lapse as most PCs in educational institutions are for public use and are frequent subject to rough use and frequent virus attacks. Thus, there exists a great opportunity on improvement here.

Basically what is expected is that each and every PC and Server should have an antivirus. Higher percentage of Servers are protected with antivirus but when it comes to PCs, the condition is not good. Institutions have installed antivirus on few PCs. It must be kept in mind that most I.C.T. security attacks are from inside the institution. PCs in educational institutions are in general public use. Users open websites, insert pen drives, install pirated software, etc. which might be infected and work as carriers of virus. Absence of anti-virus on PCs can be a great threat to I.C.T. security of the academic institution. It can, thus, be inferred that Higher Educational Institutions actually lack in providing adequate Antivirus protection.

4.4.7 EXTEND TO WHICH SELECT FACTORS PLAY A MAJOR ROLE IN COMMITTING OF I.C.T. SECURITY ATTACKS

Table 4.45: Factors which play major role in committing of I.C.T. security attacks

Factors	Responses of Technical Staff						Weighted Avg.	Rank
	Very Low (1)	Low (2)	Can't Say (3)	High (4)	Very High (5)	Total		
Lack of Technical staff	1 (0.9)	2 (1.8)	5 (4.5)	43 (38.7)	60 (54.1)	111 (100)	4.43	1
Carelessness of users	3 (2.7)	5 (4.5)	10 (9)	22 (19.8)	71 (64)	111 (100)	4.38	2
Lack of equipment / technology / software in the institution to avoid I.C.T. attacks	0 (0)	2 (1.8)	11 (9.9)	54 (48.6)	44 (39.6)	111 (100)	4.26	3
Lack of training to technical staff	1 (0.9)	5 (4.5)	12 (10.8)	49 (44.1)	44 (39.6)	111 (100)	4.17	4
Lack of I.C.T. Purchase and Up-gradation policy	0 (0)	2 (1.8)	9 (8.1)	80 (72.1)	20 (18)	111 (100)	4.06	5
Pirated Software	0 (0)	10 (9)	10 (9)	61 (55)	30 (27)	111 (100)	4	6
Low financial Budget for I.C.T. infrastructure	2 (1.8)	15 (13.5)	4 (3.6)	52 (46.8)	38 (34.2)	111 (100)	3.98	7
Budget	0 (0)	9 (8.1)	12 (10.8)	67 (60.4)	23 (20.7)	111 (100)	3.94	8
Lack of User awareness about Risks, cyber laws, etc.	0 (0)	12 (10.8)	10 (9)	72 (64.9)	17 (15.3)	111 (100)	3.85	9
Lack of concrete I.C.T. security policy	1 (0.9)	6 (5.4)	24 (21.6)	70 (63.1)	10 (9)	111 (100)	3.74	10
Lack of management support	8 (7.2)	5 (4.5)	20 (18)	67 (60.4)	11 (9.9)	111 (100)	3.61	11
User inquisitiveness to try new ways of hacking/ bypassing security/ install free software	0 (0)	18 (16.2)	17 (15.3)	70 (63.1)	6 (5.4)	111 (100)	3.58	12
Lack of Physical security (unauthorized access to labs/ I.C.T. facilities leading to thefts, etc.)	2 (1.8)	18 (16.2)	33 (29.7)	35 (31.5)	23 (20.7)	111 (100)	3.53	13
Lack of hardware / data ,etc. disposal policy	2 (1.8)	34 (30.6)	20 (18)	45 (40.5)	10 (9)	111 (100)	3.24	14
Lack of Content management	2 (1.8)	15 (13.5)	62 (55.9)	25 (22.5)	7 (6.3)	111 (100)	3.18	15
Lack of Data Governance (Management/storage/dispersion) policy	0 (0)	32 (28.8)	34 (30.6)	41 (36.9)	4 (3.6)	111 (100)	3.15	16
Lack of fixation of responsibility and liabilities on users	1 (0.9)	31 (27.9)	33 (29.7)	45 (40.5)	1 (0.9)	111 (100)	3.13	17
Other reasons	1 (0.9)	15 (13.5)	64 (57.7)	31 (27.9)	0 (0)	111 (100)	3.13	18

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.45 shows the responses of respondents regarding which have played a major role in committing (or played a catalyst) I.C.T. security attacks in Higher technical Education Institutions in Pune region. Responses were taken from Technical Staff (111 Nos.)for the purpose. This respondent types was chosen for answering this particular question as they are the only respondents who actually experienced such attacks and have identified their causes and sources.

18 commonly reported factors (causes) were identified and attempt was made to identify which of these factors was playing the most crucial role. Likert's 5-point scale having the following options of Very Low Role, Low Role, Can't Say, High Role and Very High Role were used. Weightage was given to each of these options (1 to 5). Ranking was then done for each of these 18 factors.

Analysis shows that factors Lack of Technical staff, Carelessness of users, Lack of equipment / technology / software in the institution to avoid I.C.T. attacks Ranked I, II and III and showed weighted average corresponding to High Role.

*Lack of hardware / data ,etc. disposal policy,Lack of Content management,Lack of Data Governance (Management/storage/dispersion) policy,*and *Lack of fixation of responsibility and liabilities on users*which are ranked at 14th, 15th, 16th and 17th rank show weighted averages which correspond to Can't Say responses from respondents. Further analysis of these factors reveal that in case of*Lack of hardware / data, disposal policy (9.55%), Lack of Content management (28.83%), Lack of Data Governance (Management/storage/dispersion) policy(40.54%),* and *Lack of fixation of responsibility and liabilities on users(41.44%)* Technical Respondents have stated that these factors have a High Role in committing of I.C.T. Security attacks.

Another factor of interest is *Pirated software* where 90.09% respondents have stated that it plays High Role in committing of I.C.T. Security attacks.

There are some other factors also which have been stated by Respondents in *Others* category which are of interest. Some of these factors include Allowing students to access internet on Mobile smart phones, *Allowing students to use Pen drives on PCs*, *Exchanging user passwords by users with other users*, *Careless of users while browsing internet which causes installing of Spyware and Adware*, *No antivirus on machines*, *Antivirus not updating its virus database*,etc. Researcher also came across a peculiar case where respondents said that their *Lab PCs had antivirus but there was no regular internet in labs to update them*.

SUMMARY:

Lack of Technical staff (92.79% high role responses), Carelessness of users(83.78% high role responses), Lack of equipment / technology / software in the institution to avoid I.C.T. attacks (88.29% high role responses) are the top three factors which play a major role in committing of I.C.T. security attacks. Whereas *Lack of hardware / data, etc. disposal policy (*49.55% high role responses*), Lack of Content management* (28.83% high role responses*), Lack of Data Governance (Management/storage/dispersion) policy (*40.54*%* high role responses*)*, and *Lack of fixation of responsibility and liabilities on users* (41.44% high role responses) find their place at the bottom of the list.

Another factor of interest is *Pirated software* where 90.09% respondents have stated that it plays High Role in committing of I.C.T. Security attacks.

Here are some other factors also which have been stated by Respondents in *Others* category which are of interest. Some of these factors include *Allowing students to access internet on Mobile smart phones*, *Allowing students to use Pen drives on PCs*, *Exchanging user passwords by users with other users*, *Careless of users while browsing internet which causes installing of Spyware and Adware*, *No antivirus on machines*, *Antivirus not updating its virus database*, etc. Researcher also came across a peculiar case where respondents said that their *Lab PCs had antivirus but there was no regular internet in labs to update them*.

It needs to be noted that each factor doesn't by itself causes attacks or increases the risk of attacksbut when one or more of them come together I.C.T. attacks become imminent.

4.4.8 SUCCESS EXTENT OF FACTORS IN BEING ABLE TO REDUCE / PREVENT I.C.T. SECURITY LAPSE OR ATTACK

Attempt has been made to find out factors which might be playing important role in reducing/preventing I.C.T. security attacks. For the purpose primary data was collected from I.C.T. Technical Staff and Full-Time Teaching Staff.

Table 4.46: Factors playing major role in reducing / preventing I.C.T. security lapse or attack (As per Technical Staff responses)

Item	No. Of Respondents (Technical Staff) (1- Very Low Role, 2-Low Role, 3-Average Role, 4-High Role, and 5- Very High Role)						Weighted Avg.	Rank
	1	2	3	4	5	Total		
Antivirus, firewall, auto-updates, etc.	0 (0)	0 (0)	10 (9.01)	36 (32.43)	65 (58.56)	111 (100)	4.5	1
Technical staff able to manage I.C.T. infrastructure and its security	0 (0)	9 (8.11)	15 (13.51)	25 (22.52)	62 (55.86)	111 (100)	4.26	2
Educating of staff and students about I.C.T. laws and Best Practices	0 (0)	8 (7.21)	28 (25.23)	57 (51.35)	18 (16.22)	111 (100)	3.77	3
Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets	11 (9.91)	23 (20.72)	44 (39.64)	27 (24.32)	6 (5.41)	111 (100)	2.95	4
Physical security of campus / building like CCTV, biometric access controls	2 (1.8)	46 (41.44)	28 (25.23)	32 (28.83)	3 (2.7)	111 (100)	2.89	5
Security audit able to find gaps in I.C.T. security	9 (8.11)	35 (31.53)	52 (46.85)	15 (13.51)	0 (0)	111 (100)	2.66	6

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.46 depictsthe list of Factors which might play a major role in reducing / preventing I.C.T. security lapse or attack in Higher Technical Education Institutions in Pune region. For the purpose responses were taken from Technical Staff (110 Nos.).

6 common factors were taken and respondents were asked to rate them on a rating scale from 1 to 5 (where 1- Very Low Role, 2-Low Role, 3-Average Role, 4-High Role, and 5-Very High Role) based on what level of role each might play according to them.

As is evident from **Table 4.46**, Antivirus, firewall, auto-updates, etc. (4.5) Ranks at No. 1, and comes under the category of Very High role. This is followed by Technical staff able to manage I.C.T. infrastructure and its security (4.26) and Educating of staff and students about I.C.T. laws and Best Practices (3.77) which come in the category of High Role.Security audit able to find gaps in I.C.T. security (2.66) shows that it falls in Average Role category and finds its place at the end of the list.

Table 4.47: Factors playing major role in reducing / preventing I.C.T. security lapse or attack (As per Full-Time Teaching Staff responses)

Factors	No. Of Respondents (Teaching Staff) (1- Very Low Role, 2-Low Role, 3-Average Role, 4-High Role, and 5- Very High Role)						Wt. Avg.	Rank
	1	2	3	4	5	Total		
Technical staff able to manage I.C.T. infrastructure and its security	20 (6)	64 (19.3)	80 (24.1)	137 (41.3)	31 (9.3)	332 (100)	3.29	1
Educating of staff and students about I.C.T. laws and Best Practices	35 (10.5)	30 (9)	87 (26.2)	171 (51.5)	9 (2.7)	332 (100)	3.27	2
Physical security of campus / building like CCTV, biometric access controls	63 (19)	62 (18.7)	88 (26.5)	24 (7.2)	95 (28.6)	332 (100)	3.08	3
Antivirus, firewall, auto-updates, etc.	63 (19)	62 (18.7)	88 (26.5)	24 (7.2)	95 (28.6)	332 (100)	3.08	4
Security audit able to find gaps in I.C.T. security	59 (17.8)	110 (33.1)	134 (40.4)	24 (7.2)	5 (1.5)	332 (100)	2.42	5
Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets	95 (28.6)	116 (34.9)	83 (25)	27 (8.1)	11 (3.3)	332 (100)	2.23	6

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.47depictsthe list of Factors which might play a major role in reducing / preventing I.C.T. security lapse or attack in Higher Technical Education Institutions in Pune region as per responses from Full-Time teaching Staff. For the purpose responses were taken from Technical Staff (332 Nos.).

6 common factors were taken and respondents were asked to rate them on a rating scale from 1 to 5 (where 1- Very Low Role, 2-Low Role, 3-Average Role, 4-High Role, and 5-Very High Role) based on what level of role each might play according to them.

As is evident from table 4.34a, Technical staff able to manage I.C.T. infrastructure and its security(3.29) is ranked First, followed by Educating of staff and students about I.C.T. laws and Best Practices (3.27), and Physical security of campus / building like CCTV, biometric access controls (3.08) at the Second and Third Rank respectively. All these fall in the category of Average Role.

Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets (2.23) comes at the bottom of the list falls in the Low Role category.

Table 4.48: Factors playing major role in reducing / preventing I.C.T. security lapse or attack (Integrated)

Factors	Technical Staff			Teaching Staff			Total (Freq*Wt. Avg.)	Combined Avg.	Rank
	Wt. Avg.	Frequency	Wt. Avg. * Freq.	Wt. Avg.	Frequency	Wt. Avg * Freq.			
Technical staff able to manage I.C.T. infrastructure and its security	4.26	111	473	3.29	332	1091	1564	3.53	1
Antivirus, firewall, auto-updates, etc.	4.50	111	499	3.08	332	1022	1521	3.43	2
Educating of staff and students about I.C.T. laws and Best Practices	3.77	111	418	3.27	332	1085	1503	3.39	3
Physical security of campus / building like CCTV, biometric access controls	2.89	111	321	3.08	332	1022	1343	3.03	4
Security audit able to find gaps in I.C.T. security	2.66	111	295	2.42	332	802	1097	2.48	5
Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets	2.95	111	327	2.23	332	739	1066	2.41	6

*Data retrieved from Tables 4.46 & 4.47

Table 4.48 depictsan overall scenario w.r.t. the factors which might play a major role in reducing / preventing I.C.T. security lapse or attack in Higher Technical Education Institutions in Pune region as per responses from Full-Time teaching Staff. For the purpose responses were taken from Technical Staff (332 Nos.) and Full-Time teaching Staff (111 Nos.).

6 common factors were taken and respondents were asked to rate them on a rating scale from 1 to 5 (where 1- Very Low Role, 2-Low Role, 3-Average Role, 4-High Role, and 5-Very High Role) based on what level of role each might play according to them.

As is evident from Table 4.48, *Technical staff able to manage I.C.T. infrastructure and its security*(3.53) ranks **First** and falls under *High Role*, followed by*Antivirus, firewall, auto-updates, etc.*(3.43) ranks **Second**, and *Educating of staff and students about I.C.T. laws and Best Practices*(3.39) ranks **Third.**All these fall under *Average* role.

Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets(2.41) comes under the category of *Low Role* and finds its place at the bottom of the list.

SUMMARY:

As Technical Staff, *Antivirus, firewall, auto-updates, etc.* (4.5) followed by *Technical staff able to manage I.C.T. infrastructure and its security* (4.26) and *Educating of staff and students about I.C.T. laws and Best Practices* (3.77) are top most factors which reduce I.C.T. attacks.

As Teaching Staff, *Technical staff able to manage I.C.T. infrastructure and its security* (3.29), followed by *Educating of staff and students about I.C.T. laws and Best Practices* (3.27), and *Physical security of campus / building like CCTV, biometric access controls* (3.08) are top most factors which reduce I.C.T. attacks.

Overall, *Technical staff able to manage I.C.T. infrastructure and its security*(3.53) ranks **First**, followed by *Antivirus, firewall, auto-updates, etc.* at **Second**, and *Educating of staff and students about I.C.T. laws and Best Practices* at **Third.**

Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets(2.41) comes under the category of *Low Role* and finds its place at the bottom of the list.

Thus, it can be inferred that *Technical staff able to manage I.C.T. infrastructure and its security* and *Antivirus, firewall, auto-updates, etc.* are the factors that respondents feel have played most important role in curbing I.C.T. security attacks in institutions of Higher Technical education.

4.4.9 AREAS THAT NEED TO BE ADDRESSED TO IMPROVE I.C.T. SECURITY IN THE INSTITUTES

Table 4.49: Areas to be addressed to improve I.C.T. security in the institutes

Areas for Improving I.C.T. Security	Technical Staff responses				Full-Time Teaching Staff responses				Full-Time Student responses			
	Yes	Can't Say	No	Total	Yes	Can't Say	No	Total	Yes	Can't Say	No	Total
(a) User Awareness about cyber laws	80 (72.1)	25 (22.5)	6 (5.4)	111 (100)	291 (87.65)	19 (5.72)	22 (6.63)	332 (100)	381 (87.6)	51 (11.7)	3 (0.7)	435 (100)
(b) Delegation and Fixation of responsibility	72 (64.9)	36 (32.4)	3 (2.7)	111 (100)	281 (84.64)	26 (7.83)	25 (7.53)	332 (100)	256 (58.9)	173 (39.8)	6 (1.4)	435 (100)
(c) Stringent penalties	83 (74.8)	18 (16.2)	10 (9)	111 (100)	246 (74.1)	48 (14.46)	38 (11.45)	332 (100)	120 (27.6)	153 (35.2)	162 (37.2)	435 (100)
(d) Train users to identify I.C.T.security risks	77 (69.4)	24 (21.6)	10 (9)	111 (100)	287 (86.45)	28 (8.43)	17 (5.12)	332 (100)	374 (86.0)	59 (13.6)	2 (0.5)	435 (100)
(e) Understanding and awareness of available security responses	61 (55)	36 (32.4)	14 (12.6)	111 (100)	285 (85.84)	25 (7.53)	22 (6.63)	332 (100)	249 (57.2)	165 (37.9)	21 (4.8)	435 (100)
(f) Identification and blocking loopholes in security	81 (73)	21 (18.9)	9 (8.1)	111 (100)	277 (83.43)	31 (9.34)	24 (7.23)	332 (100)	349 (80.2)	80 (18.4)	6 (1.4)	435 (100)
(g) Changes in routines, beliefs and informal norms used in the organization	49 (44.1)	51 (45.9)	11 (9.9)	111 (100)	272 (81.93)	32 (9.64)	28 (8.43)	332 (100)	243 (55.9)	174 (40)	18 (4.1)	435 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.49 depicts the Areas to be addresses to improve I.C.T. security in the institutes. For the purpose responses were collected from Technical Staff (111 Nos.), Full-time Teaching Staff (332 Nos.), and Full-Time Students (435 Nos.).

Technical staff have given highest *Yes* responses for *Stringent penalties* (74.8%) which is followed by*Identification and blocking loopholes in security* (73.0%) and *User Awareness about cyber laws*(72.0%), while Full-Time Teaching Staff has given highest *Yes* responses for *User Awareness about cyber laws* (87.65%). Full-Time Students have given also highest responses for Yes for *User Awareness about cyber laws*(87.6%).

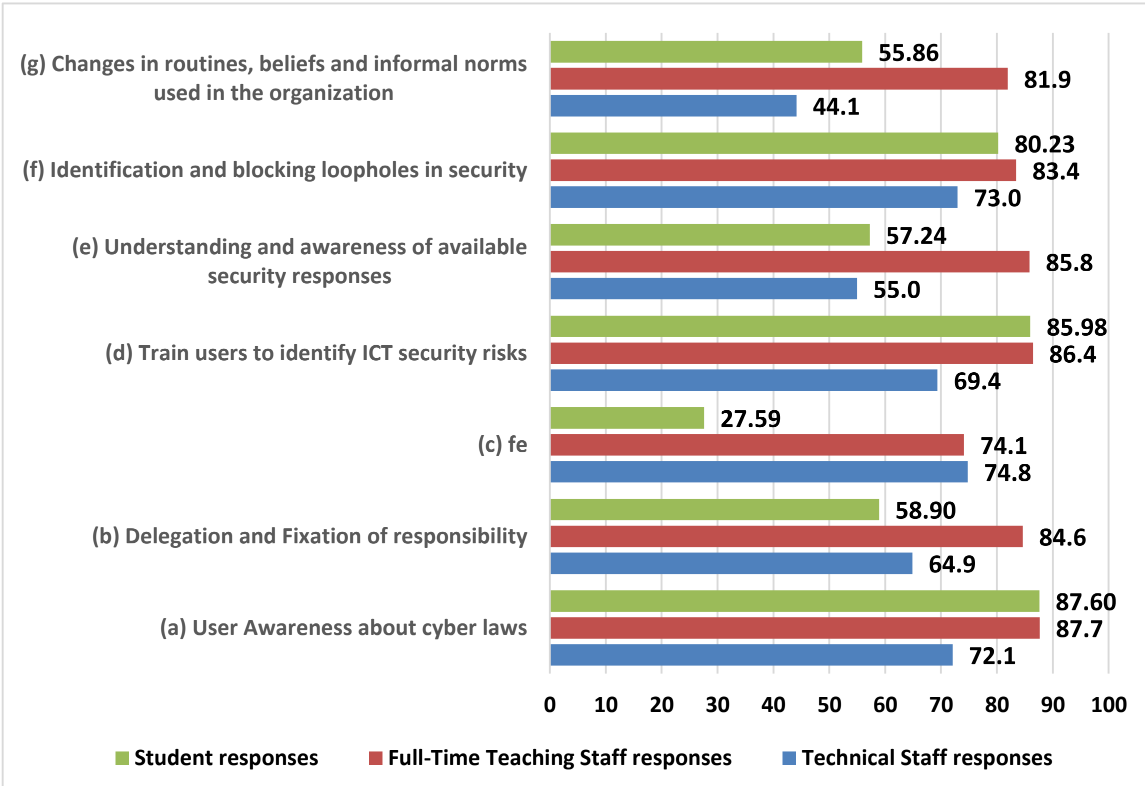
Table 4.50: Areas to be addresses to improve I.C.T. security in the institutes (integrated)

Areas to Address	Yes Responses			Total Yes	Total overall Respondents	Percentage
	Technical	Teaching	Students			
(a) User Awareness about cyber laws	80	291	381	752	878	85.65
(d) Train users to identify I.C.T. security risks	77	287	374	738	878	84.05
(f) Identification and blocking loopholes in security	81	277	349	707	878	80.52
(b) Delegation and Fixation of responsibility	72	281	256	609	878	69.36
(e) Understanding and awareness of available security responses	61	285	249	595	878	67.77
(g) Changes in routines, beliefs and informal norms used in the organization	49	272	243	564	878	64.24
(c) Stringent penalties	83	246	120	449	878	51.14

*Data derived from Table 4.49

As per **Table 4.50**, Overall, User Awareness about cyber laws (85.65%), Train users to identify I.C.T. security risks (84.05%), and Identification and blocking loopholes in security (80.52%) are the top-most Areas need to be addresses to improve I.C.T. security in the institutes. Whereas Stringent Penalties are least related as per combined responses of all respondents.

Graph 4.15: Areas to be addresses to improve I.C.T. security in the institutes



Graph 4.15 shows a stacked graph depicting Areas to be addresses to improve I.C.T. security in the institutes which for respondents have shown a positive reply. As is evident, on overall basis *User Awareness about cybercrime* has topped the list, followed by *Train users to identify I.C.T. security risks* and *Identification and blocking loopholes* in security. The least preferred area is *Stringent Penalties*.

SUMMARY:

Above data shows that there is a difference in perception of Technical Staff and Users viz. Full-Time Teaching Staff and Full-Time Students. According to Technical Staff feels that *Identification and blocking loopholes in security* is most important factor because these respondents look at things from technical and operational perspective.

Teaching Staff and Students look at things from end-user's perspective and that's why they both have unanimously given first preference to *User Awareness about cyber laws.*

Overall it is the *User Awareness about cybercrime* has topped the list but though Technical staff has highly recommended still other users viz. Teaching Staff and Students are not in favour of using Stringent Penalties as a way to Reduce or Prevent I.C.T. security attacks. We must also understand that all attacks are not caused by humans (knowingly or unknowingly) so applying penalty is not easy to implement.

4.4.10 CURRENT I.C.T. SCENARIO FROM USER'S VIEWPOINT

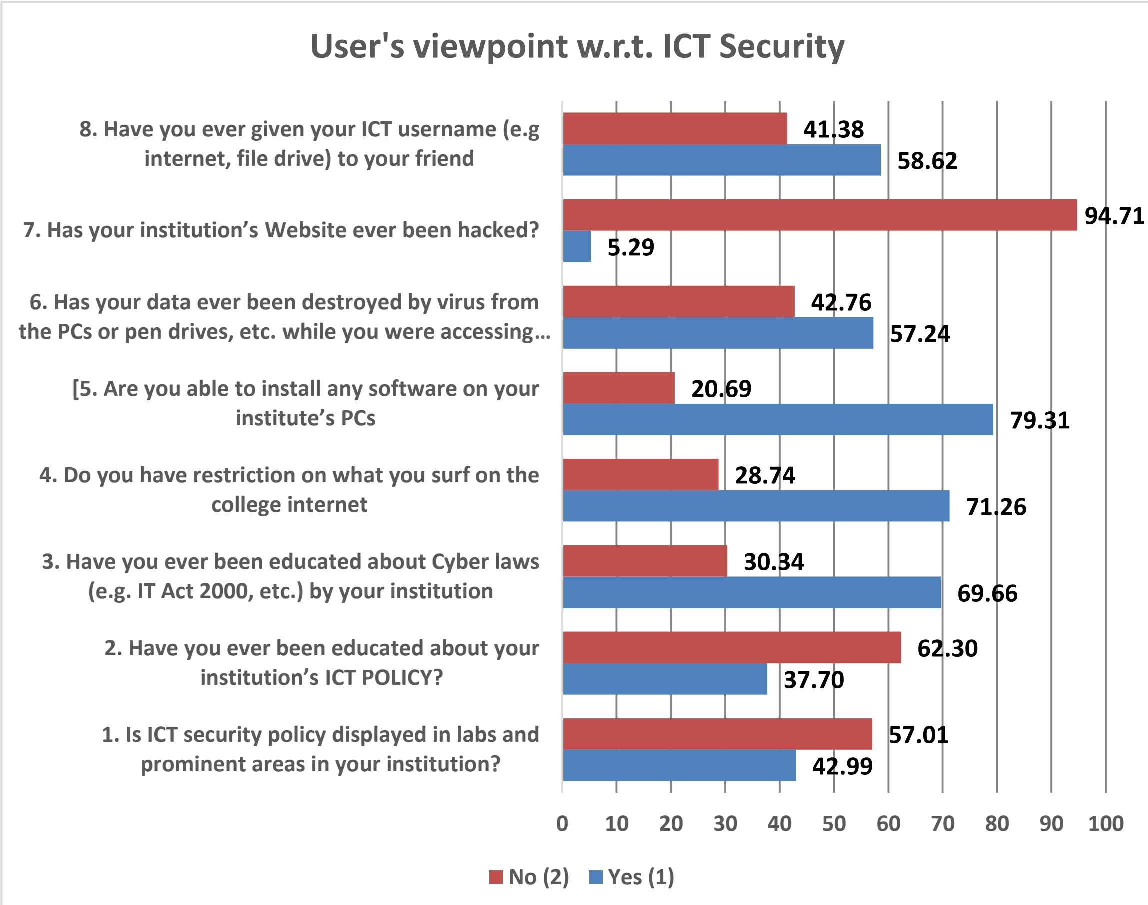
Table 4.51: Current I.C.T. scenario from Student User's prospective

Points w.r.t. current I.C.T. scenario	(Response) Frequency		
	Yes (1)	No (2)	Total
1. Is I.C.T. security policy displayed in labs and prominent areas in your institution?	187 (43)	248 (57)	435 (100)
2. Have you ever been educated about your institution's I.C.T. POLICY?	164 (37.7)	271 (62.3)	435 (100)
3. Have you ever been educated about Cyber laws (e.g. IT Act 2000, etc.) by your institution	303 (69.7)	132 (30.3)	435 (100)
4. Do you have restriction on what you surf on the college internet	310 (71.3)	125 (28.7)	435 (100)
5. Are you able to install any software on your institute's PCs	345 (79.3)	90 (20.7)	435 (100)
6. Has your data ever been destroyed by virus from the PCs or pen drives, etc. while you were accessing it on your Institute's PC	249 (57.2)	186 (42.8)	435 (100)
7. Has your institution's Website ever been hacked?	23 (5.3)	412 (94.7)	435 (100)
8. Have you ever given your I.C.T. username (e.g. internet, file drive) to your friend	255 (58.6)	180 (41.4)	435 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.51 depicts responses of Users w.r.t. the I.C.T. security in the institutes. 8 factors have been taken to study the I.C.T. security scenario. Responses in the form of Yes, No have been taken for each points (factor). For the purpose responses were collected from Full-Time Students (435 Nos.).

Graph 4.16: Current I.C.T. scenario from User's viewpoint



Graph 4.16 and **Table 4.51** depict the various factors which may give us a clear picture of the current I.C.T. security scenario in institutions of Technical Higher Education. The given data can be analysed in two parts:

<u>Discrepancies found:</u>

a. Only 43% students stated that Is I.C.T. security policy displayed in labs and prominent areas in the institution.

b. Only 37.7% students stated that been educated about your institution's I.C.T. POLICY.

c. 79.3% students stated that they you able to install any software on their institute's PCs

d. 57.2% students stated that their data was destroyed by virus from the PCs or pen drives, etc. while they were accessing it on your Institute's PC.

e. 58.6% students stated that they shared their I.C.T. username (e.g. internet, file drive) with their friends.

Positive aspect:

a. 69.7% students said that they have been educated about Cyber laws (e.g. IT Act 2000, etc.) by your institution

b. 71.3% students stated that there is restriction on what is surf on the college internet.

c. 5.3% students stated that institution's Website was hacked.

As is evident, there are 2 factors namely *I.C.T.Security policy displayed in labs and prominent areas the institution, Have you ever been educated about your institution's I.C.T. Policy* where respondent's given more NO responses 57.01% and 62.30% respectively. This means that institutions might not have a formally drafted I.C.T. security policy or they have failed to display it to general public users. Another important point to note here is that students have not been educated about the existence of an I.C.T. security policy if it actually exists. This is a bad situation because if students have not been educated or enlightened about the various rules for I.C.T. usage covered under I.C.T. security policy, then how will they understand what they should do and what they shouldn't when using institution's I.C.T. infrastructure and services.

Certain other discrepancies were found with points like 79.3% respondents said they were able to install any software on their institution's PCs. Again, when it came to *Sharing I.C.T. username (e.g. internet, file drive) with friend*, 58.6% respondents said that they have done so.Similarly, 57.2% respondents have stated that their *data was destroyed by virus from the PCs or pen drives, etc. while they were accessing it on Institute's PC.*

A positive thing that has been observed when respondents were asked about whether their *institution's Website ever been hacked.* Here, only 5.29% respondents said that it was hacked. Another positive thing observed was with *Have you ever been educated about*

Cyber laws (e.g. IT Act 2000, etc.) by your institution where 69.7% respondents said that their institution educated them about Cyber laws.

SUMMARY:

Here we can conclude that there are many factors which can become a possible means in compromise of I.C.T. security. We have seen from the majority responses that people's data was destroyed by virus(57.2%). Similarly,users have shared their passwords (may be of emails, internet access, shared drives, etc.) with friends. Respondents have also reported that they are able to install any software on the institution's PC (some may be containing virus, Trojan or Spyware, etc.).

Absence of I.C.T. security policy or user's not knowing about its contents, might be because it is not displayed, is one of the biggest reasons why users indulge in activities (knowingly or unknowingly) which can lead to compromise in I.C.T. security.

4.5 BENEFITS OF USE OF I.C.T. FACILITIES AND SERVICES IN SAID INSTITUTIONS INCLUDING THEIR IMPACT ON DAY TO DAY FUNCTIONING OF THE INSTITUTIONS.

4.5.1 PERCENTAGE OF ANNUAL BUDGET SET ASIDE FOR I.C.T.

Table 4.52: Percentage of Annual Budget set for I.C.T.

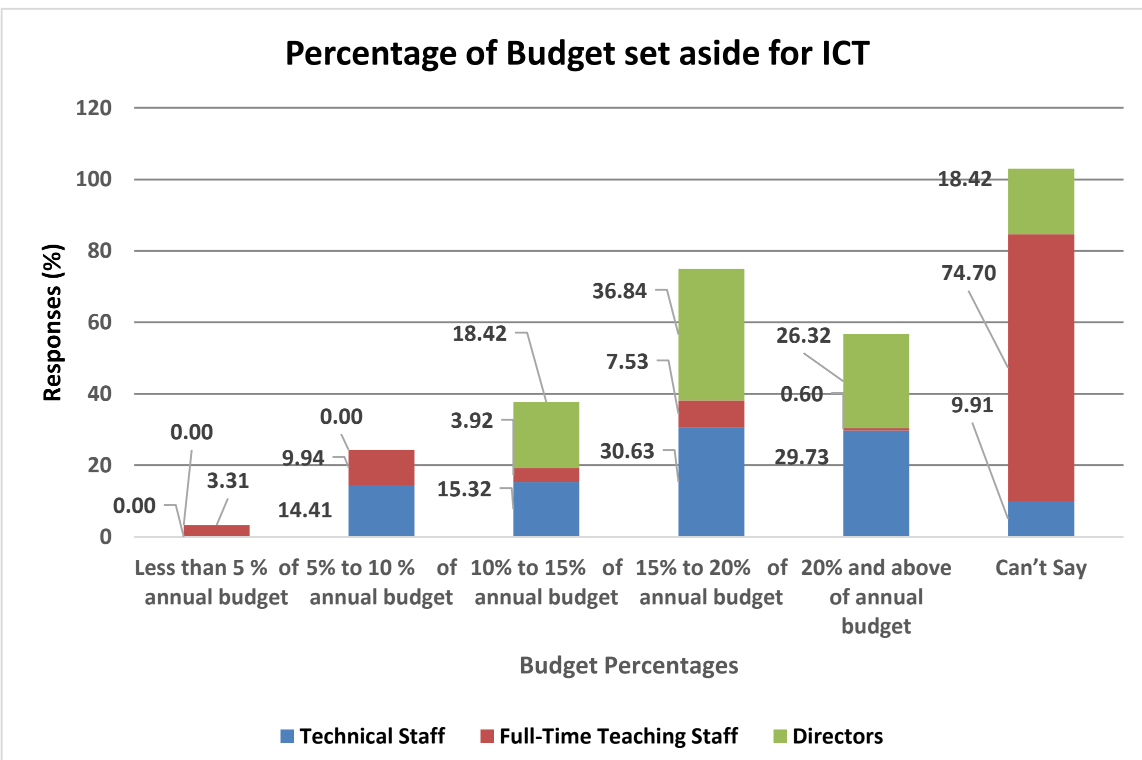
Respondent Type	Budget						Total
	Less than 5 % of annual budget	5% to 10 % of annual budget	10% to 15% of annual budget	15% to 20% of annual budget	20% and above of annual budget	Can't Say	
Technical Staff	0 (0)	16 (14.4)	17 (15.3)	34 (30.6)	33 (29.7)	11 (9.9)	111(100)
Full-Time Teaching Staff	11 (3.3)	33 (9.9)	13 (3.9)	25 (7.5)	2 (0.6)	248 (74.7)	332(100)
Head of Institute	0 (0)	7 (0)	14 (18.4)	10 (36.8)	7 (26.3)	38 (18.4)	38(100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.52represents the trends in financial budget set aside for I.C.T. by Higher Technical Educational Institutions.Responses for the same were taken from Technical Staff (111 Nos.), Full-time Teaching Staff (332 Nos.), and Head of Institute (38 Nos.). As it is not possible for respondents to divulge the exact amount, thus, respondents were asked to give their responses regarding provision for I.C.T. in Annual Budget in the form of Slabs viz. *Less than 5 % of annual budget, 5% to 10 % of annual budget, 10% to 15% of annual budget, 15% to 20% of annual budget, 20% and above of annual budget*, and *Can't Say (for those who either don't know or don't want to divulge)*

Technical Staff have given highest responses (30.6%) to *15% to 20% of annual budget*. On the other hand, Teaching Staff have shown trends which indicate that majority of them don't have information regarding this matter. Otherwise, according to them 9.9% have stated that *5% to 10 % of annual budget* is set aside for I.C.T.. The highest responses fromHead of Institute(36.8%)is for*15% to 20% of annual budget set aside for I.C.T.*.

Graph 4.17



Graph 4.17shows trends in financial budget set aside for I.C.T. by Higher Technical Educational Institutions. Overall, majority of all types of respondents have shown their inability in telling the percentage of budget allotted for I.C.T.. Apart from that, highest number of overall responses by all respondent types has been given to *15% to 20% of annual budget.* Second highest responses have been given to *20% and above of annual budget*. Least responses have been received by *Less than 5% of annual budget.*

Table 4.53: Percentage of Annual Budget set for I.C.T. (Integrated)

Respondent Type	Mean Value	Frequency (F1)	Mean Value * F1	Combined Average
Technical Staff	16.7	100	1670	18.13
Full-Time Teaching Staff	19.88	84	1669.92	
Head of Institution	17.98	31	557.38	
Total		215	3897.3	

Table 4.53 (calculations made as per data from Table 4.52) represents the overall scenario of Percentage of Annual Budget spent on I.C.T. by institutions of Higher Technical Education as per combined responses of Technical Staff, Full-Time Teaching Staff, and Heads of Institutions (Neutral responses have been ignored). As per the data presented in Table 4.53, it can be inferred that most institutions are spending only 18.13% of their total annual budget for I.C.T..

SUMMARY:

Looking at the above discussion, we find that most institutions have dedicated *15% to 20% of annual budget* for I.C.T.. In fact, as per the data presented in Table 4.38a, it can be inferred that most institutions are spending only 18.13% of their total annual budget for I.C.T.. Costs related to I.C.T. include Recurring costs like internet bills, repair and maintenance, subscriptions for anti-virus, salaries for technical staff, upgrading of hardware and software, and Non-recurring costs like buying new hardware and software, creating computer labs and laying the network and electrical cables, etc. Both non-recurring and recurring costs are quite high. Increasing dependency on I.C.T. has increased costs related to I.C.T.. 18.13% of Annual budget looks quite small in such a scenario.

4.5.2 PERCENTAGE OF ANNUAL BUDGET SET ASIDE FOR NEW PURCHASES / UP-GRADATION OF I.C.T. IS ACTUALLY USED

Table 4.54: Percentage of Annual Budget set aside for New Purchases / Up-gradation of I.C.T. is actually used

Respondent Type	Percentage of Annual Budget set aside for New purchases / Up-gradation of I.C.T. is actually used						
	Less than 20 % of sanctioned I.C.T. budget	20% to 40 % of sanctioned I.C.T. budget	40% to 60% of sanctioned I.C.T. budget	60% to 80% of sanctioned I.C.T. budget	80% and above of sanctioned I.C.T. budget	Can't Say	Total
Technical Staff	2 (1.8)	21 (18.9)	31 (27.9)	8 (7.2)	9 (8.1)	40 (36)	111 (100)
Full-Time Teaching Staff	15 (4.5)	47 (14.2)	23 (6.9)	7 (2.1)	1 (0.3)	239 (72)	332 (100)
Head of Institute	0 (0)	1 (2.6)	4 (10.5)	14 (36.8)	8 (21.1)	11 (28.9)	38 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

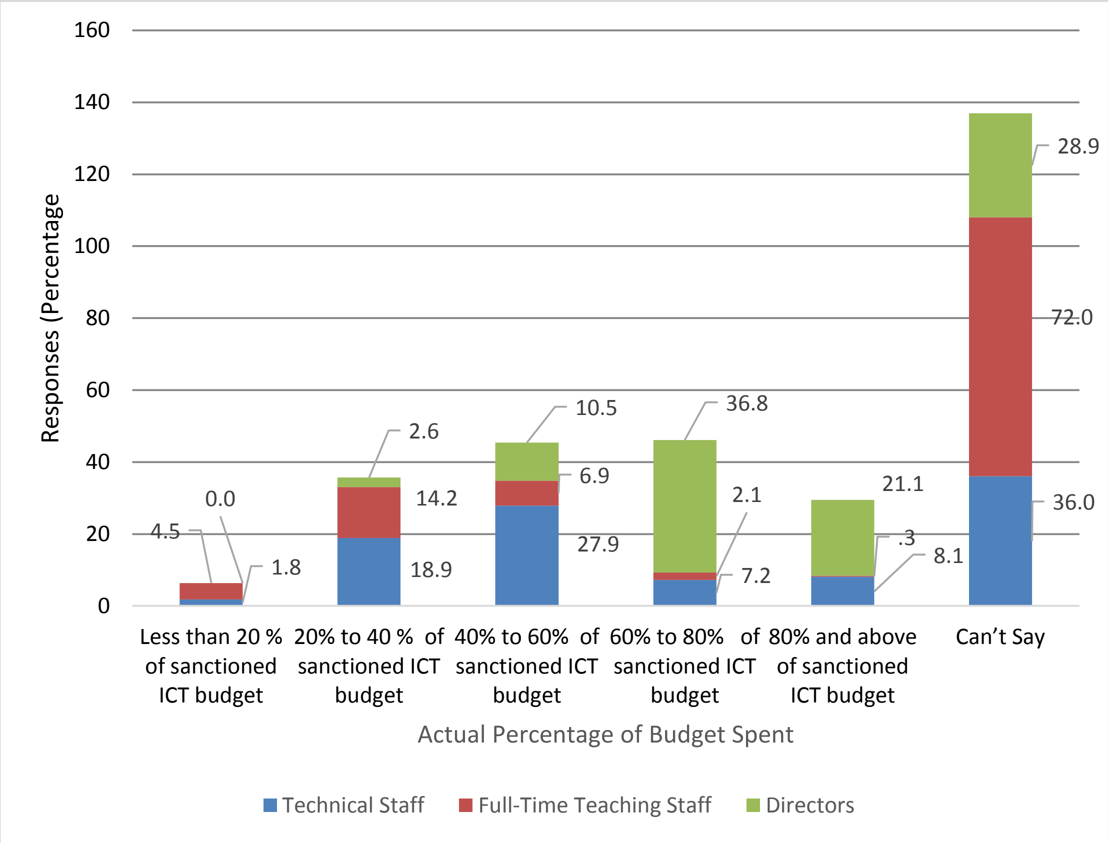
Table 4.54 represents the trends in actual spending from financial budget set aside for I.C.T. by Higher Technical Educational Institutions. Responses for the same were taken from Technical Staff (111 Nos.), Full-time Teaching Staff (332 Nos.), and Head of Institute (38 Nos.). As it is not possible for respondents to divulge the exact amount, thus, respondents were asked to give their responses regarding how much actual percentage of amount reserved for I.C.T. in Annual Budget in the form of Slabs viz. *Less than 20 % of sanctioned I.C.T. budget, 20% to 40 % of sanctioned I.C.T. budget, 40% to 60% of sanctioned I.C.T. budget, 60% to 80% of sanctioned I.C.T. budget, 80%* and *above of sanctioned I.C.T. budget, and Can't Say(for those who either don't know or don't want to divulge)***.**

As per Technical Staff, the highest responses have been received by (ignoring *Can't say* responses*) 40% to 60% of sanctioned I.C.T. budget* (27.9%).

As per Teaching Staff (ignoring Can't Say responses), the highest responses have been received by *20% to 40 % of sanctioned I.C.T. budget* (14.2%).

As per Head of Institute, highest responses have been received by *60% to 80% of sanctioned I.C.T. budget* (36.8%). On an average 50.28% of the budget set aside for I.C.T. is actually used.

Graph 4.18: Percentage of Annual Budget set aside for new purchases / Up-gradation of I.C.T. is actually used



Graph 4.18 shows trendsin actual spending from financial budget set aside for I.C.T. by Higher Technical Educational Institutions. Overall, majority of all types of respondents have shown their inability in telling the percentage of budget allotted for I.C.T.. Apart from that, highest number of overall responses by all respondent types has been given to *60% to 80% of sanctioned I.C.T. budget.* Second highest responses have been given to *40% to 60% of sanctioned I.C.T. budget*. Least responses have been received by *Less than 20% of sanctioned I.C.T. budget.*

Table 4.55: Percentage of Annual Budget set aside for New Purchases / Up-gradation of I.C.T. is actually used (Integrated)

Respondent Type	Mean value	Frequency	Mean Value*Frequency	Combined Average
Technical Staff	50.28	71	3569.88	
Full-Time Teaching Staff	35.38	93	3290.34	53.14
Head of Institution	121.85	27	3289.95	
Total		191	10150.17	

*Data for Table 4.55 derived from Table 4.54

Table 4.55represents the overall scenario of Percentage of Annual Budget set aside for New Purchases / Up-gradation of I.C.T. which is actually used by institutions of Higher Technical Education as per combined responses of Technical Staff, Full-Time Teaching Staff, and Heads of Institutions (Neutral responses have been ignored). As per the data presented in Table 4.59, it can be inferred that most institutions are actually spending only 53.14% of their total Annual Budget set aside for New Purchases / Up-gradation of I.C.T..

SUMMARY:

Above data has shown that even though provisions have been made in Budgets by Higher Technical educational institutions (refer section 4.6.1) still this amount is not fully spent. Overall, approximately 53.14% of the total Annual Budget set aside for New Purchases / Up-gradation of I.C.T. by Higher Technical Education Institution is being allocated for I.C.T. is actually used.

This is an alarming condition as this means that Non-recurring and Recurring expenditures on I.C.T. are not met which may lead to problems in buying anti-virus, firewalls, repairing / replacing old machines, etc. culminating in higher rate of network and machine failures, loss of data, etc.

4.5.3 INVESTMENT IN I.C.T. INFRASTRUCTURE IS EVERY PENNY WORTH SPENT

Table 4.56: Investment in I.C.T. infrastructure is every penny worth spent

Respondent Type	Investment in I.C.T. infrastructure is every penny worth spent.					
	Strongly Disagree	Disagree	Can't say	Agree	Strongly Agree	Strongly Disagree
Technical Staff	0 (0)	3 (2.7)	15 (13.5)	29 (26.1)	64 (57.7)	111 (100)
Full-Time Teaching Staff	3 (0.9)	0 (0)	37 (11.14)	55 (16.57)	237 (71.39)	332 (100)
Head of Institute	0 (0)	0 (0)	0 (0)	0 (0)	38 (100)	38 (100)

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.56 depicts responses of respondents from Institutions of Higher Technical Education regarding what they feel about investment in I.C.T. infrastructure.Responses for the same were taken from Technical Staff (111 Nos.), Full-Time Teaching Staff (332 Nos.), and Head of Institute (38 Nos.).

Likert's 5-point scale having the following options of Strongly Disagree, Disagree, Can't Say, Agree, and Strongly Agree were used. Weightage was given to each of these options viz. 1 to 5 respectively.

As is evident from Table 4.56, All the 3 types of respondents have given highest responses for Strongly Agree viz. Technical Staff(57.7%), Full-Time Teaching Staff (71.39%), and Head of Institute (100%).

Table 4.57: Investment in I.C.T. infrastructure is every penny worth spent (Integrated)

Respondent Type	Strongly Disagree (1)	Disagree (2)	Can't say (3)	Agree (4)	Strongly Agree (5)	Total	Wt. Avg	Wt. Avg * No of resps	Combined Avg.
Technical Staff	0	3	15	29	64	111	4.39	487.29	4.57
Full-Time Teaching Staff	3	0	37	55	237	332	4.58	1519	
Head of Institution	0	0	0	0	38	38	5.00	190	
Total:						481		2196.29	

* Data for Table 4.57 derived from Table 4.56

Table 4.57 depicts overall responses of respondents from Institutions of Higher Technical Education regarding what they feel about investment in I.C.T. infrastructure. Responses for the same were taken from Technical Staff (111 Nos.), Full-Time Teaching Staff (332 Nos.), and Head of Institute (38 Nos.).

It is evident from Table 4.57, the combined weighted average of 4.57 indicates that on overall respondents *Strongly Agree* to the statement that "Investment in I.C.T. infrastructure is every penny worth spent".

SUMMARY:

As is evident from the discussions, all types of respondents have unanimously agreed that Investment in I.C.T. is every penny worth. This means that people have understood the importance of I.C.T. in education especially Higher technical Education and have indirectly expressed their feeling regarding investing in I.C.T. infrastructure in their educational institutions. From the combined weighted average of 4.57 inferred that overall respondents *Strongly Agree* to the statement that "*Investment in I.C.T. infrastructure is every penny worth spent"*.

4.5.4 EXTENT OF BENEFITS OR MAXIMUM RETURN ON INVESTMENTS ON I.C.T.

Table 4.58: Extent of benefits or maximum Return on Investments on I.C.T. as per Technical Staff responses

Areas of Return/ Benefit	Responses of Technical Staff (Benefits / Return on Investment)						Weighted Avg.	Rank
	Very Low (1)	Low (2)	Can't Say (3)	High (4)	Very High (5)	Total		
Communication	0 (0)	0 (0)	11 (9.91)	69 (62.16)	31 (27.93)	111 (100)	4.18	1
Stationary (e.g. paperless office)	0 (0)	7 (6.31)	19 (17.12)	44 (39.64)	41 (36.94)	111 (100)	4.07	2
Information storage and access	0 (0)	2 (1.8)	14 (12.61)	72 (64.86)	23 (20.72)	111 (100)	4.05	3
Research	0 (0)	10 (9.01)	8 (7.21)	75 (67.57)	18 (16.22)	111 (100)	3.91	4
Administration	1 (0.9)	17 (15.32)	42 (37.84)	26 (23.42)	25 (22.52)	111 (100)	3.51	5
Manpower (Teaching, Non-teaching, etc.) staff	0 (0)	13 (11.71)	51 (45.95)	41 (36.94)	6 (5.41)	111 (100)	3.36	6
Examination process	0 (0)	26 (23.42)	27 (24.32)	53 (47.75)	5 (4.5)	111 (100)	3.33	7
Decision making	1 (0.9)	12 (10.81)	66 (59.46)	19 (17.12)	13 (11.71)	111 (100)	3.28	8
Automation and integration	5 (4.5)	11 (9.91)	55 (49.55)	33 (29.73)	7 (6.31)	111 (100)	3.23	9
Others	9 (8.11)	3 (2.7)	89 (80.18)	10 (9.01)	0 (0)	111 (100)	2.9	10

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.58 depicts the perception trends w.r.t. Extent of benefits or Return on Investments in I.C.T. received from various areas as per responses of Technical Staff. 111 responses were taken from this category of Respondents. The purpose was to find the extent of Returns / benefits provided by various areas related to Higher Technical Education Institutions due to investments in I.C.T. in these institutions. Likert's 5-point scale having the following options of Very Low, Low,Can't Say, High and Very High were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common areas of return (Research, Communication, etc.) based on

Weighted Average calculated for each of these items. Ranking was then created to find areas which showed high returns and those which portrayed low returns.

As per Technical Staff Respondent's views (Refer Table 4.62), *Communication* has Ranked at No. 1 (90.09% high Return on Investment responses) followed by *Stationary (e.g. paperless office)*(Rank 2; 76.58% high Return on Investment responses), *and Information storage and access*(Rank 3; 85.58% high Return on Investment responses) and show weighted averages that correspond to*High* Return.

Areas like *Manpower (Teaching, Non-teaching, etc.) staff, Examination process, Decision making, Automation* and *integration,* and *Others* depict weighted averages which point out towards Can't Say responses.

On further analysis it is found that in case of *Manpower (Teaching, Non-teaching, etc.) staff* the responses for *High* return (42.34%) are more than those for *Low* (11.71%).

In case of *Examination process,* the responses for *High* return (52.25%) are more than those for *Low* returns (23.42%). This indicates that technical Staff feels that there is positive benefit / Return in this particular area from Investment in I.C.T..

In case of *Decision making,* the responses for *High* return (28.83%) are more than those for *Low* returns (11.71%). This indicates that technical Staff feels that there is positive benefit / Return in this particular area from Investment in I.C.T..

In case of *Automation* and *integration,* the responses for *High* return (36.04%) are more than those for *Low* returns (14.41%). This indicates that technical Staff feels that there is positive benefit / Return in this particular area from Investment in I.C.T..

A good area of return suggested by *Technical Staff was the Maintenance and Trouble Shooting costs* associated with I.C.T. infrastructure.

We can, thus, conclude that as per Technical Staff it is the Communications where the institution has received maximum benefit / Return of Investment.

Table 4.59: Extent of benefits or maximum Return on Investments on I.C.T. as per Full-Time Teaching Staff responses

Areas of Return/ Benefit	Responses of Full-Time Teaching Staff						Weighted Avg.	Rank
	Very Low (1)	Low (2)	Can't Say (3)	High (4)	Very High (5)	Total		
Research	0 (0)	3 (0.9)	5 (1.51)	75 (22.59)	249 (75)	332 (100)	4.72	1
Communication	0 (0)	0 (0)	11 (3.31)	92 (27.71)	229 (68.98)	332 (100)	4.66	2
Automation and integration	0 (0)	7 (2.11)	29 (8.73)	64 (19.28)	232 (69.88)	332 (100)	4.57	3
Examination process	0 (0)	4 (1.2)	8 (2.41)	205 (61.75)	115 (34.64)	332 (100)	4.3	4
Information storage and access	1 (0.3)	5 (1.51)	23 (6.93)	191 (57.53)	112 (33.73)	332 (100)	4.23	5
Administration	0 (0)	4 (1.2)	12 (3.61)	218 (65.66)	98 (29.52)	332 (100)	4.23	6
Manpower (Teaching, Non-teaching, etc.) staff	3 (0.9)	3 (0.9)	22 (6.63)	199 (59.94)	105 (31.63)	332 (100)	4.2	7
Decision making	0 (0)	4 (1.2)	32 (9.64)	201 (60.54)	95 (28.61)	332 (100)	4.17	8
Stationary (e.g. paperless office)	0 (0)	17 (5.12)	148 (44.58)	59 (17.77)	108 (32.53)	332 (100)	3.78	9
Others	0 (0)	7 (2.11)	288 (86.75)	19 (5.72)	18 (5.42)	332 (100)	3.14	10

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.59 depicts the perception trends w.r.t. Extent of benefits or Return on Investments in I.C.T. received from various areas as per responses of Full-Time Teaching Staff. 332 responses were taken from this category of Respondents. The purpose was to find the extent of Returns / benefits provided by various areas related to Higher Technical Education Institutions due to investments in I.C.T. in these institutions. Likert's 5-point scale having the following options of Very Low, Low, Can't Say, High and Very High were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common areas of return (Research, Communication, etc.) based on Weighted Average calculated for each of these items.

Ranking was then created to find areas which showed high returns and those which portrayed low returns.

As per Full-Time Teaching Staff Respondent's views (Refer Table 4.59), *Research* has Ranked at No. 1 (97.59% high return responses) followed by *Communication*(Rank 2; 96.69% high return responses), *and Automation and Integration* (Rank 3; 89.16% high returns) and show weighted averages that correspond to*Very High* Return.

Areas like *Examination process, Information storage and access, Administration, Manpower (Teaching, Non-teaching, etc.) staff, Decision making,* and *Stationary (e.g. paperless office)* depict weighted averages which point out towards *High* returns.

Thus, we can conclude that all areas under study have shown good amount of benefits / Return on Investments. Of these as per Teaching Staff respondents *Research* is the areas which gives maximum benefits.

Table 4.60: Extent of benefits or maximum Return in Investments in I.C.T. as per Head of Institute's responses

Areas of Return/ Benefit	Responses of Head of Institute (Return on Investments)						Weighted Avg.	Rank
	Very Low (1)	Low (2)	Can't Say (3)	High (4)	Very High (5)	Total		
Communication	0 (0)	0 (0)	0 (0)	5 (13.16)	33 (86.84)	38 (100)	4.87	1
Research	0 (0)	0 (0)	0 (0)	7 (18.42)	31 (81.58)	38 (100)	4.82	2
Stationary (e.g. paperless office)	0 (0)	0 (0)	0 (0)	7 (18.42)	31 (81.58)	38 (100)	4.82	3
Administration	0 (0)	0 (0)	1 (2.63)	7 (18.42)	30 (78.95)	38 (100)	4.76	4
Information storage and access	0 (0)	0 (0)	1 (2.63)	9 (23.68)	28 (73.68)	38 (100)	4.71	5
Examination process	0 (0)	0 (0)	3 (7.89)	9 (23.68)	26 (68.42)	38 (100)	4.61	6
Decision making	0 (0)	0 (0)	4 (10.53)	10 (26.32)	24 (63.16)	38 (100)	4.53	7
Automation and integration	0 (0)	0 (0)	7 (18.42)	10 (26.32)	21 (55.26)	38 (100)	4.37	8
Manpower (Teaching, Non-teaching, etc.) staff	0 (0)	2 (5.26)	6 (15.79)	8 (21.05)	22 (57.89)	38 (100)	4.32	9
Others	0 (0)	1 (2.63)	21 (55.26)	8 (21.05)	8 (21.05)	38 (100)	3.61	10

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.60 depicts the perception trends w.r.t. Extent of benefits or Return on Investments on I.C.T. received from various areas as per responses of Head of Institute. 38 responses were taken from this category of Respondents. The purpose was to find the extent of Returns / benefits provided by various areas related to Higher Technical Education Institutions due to investments in I.C.T. in these institutions. Likert's 5-point scale having the following options of Very Low, Low, Can't Say, High and Very High were used. Weightage was given to each of these options (1 to 5). Ranking was done for each common areas of return (Research, Communication, etc.) based on Weighted Average calculated for each of these items. Ranking was then created to find areas which showed high returns and those which portrayed low returns.

As per Head of Institute Respondent's views (Refer Table 4.60), *Communication* has Ranked at No. 1 (100% high benefit responses) followed by *Research* (Rank 2; 100% high benefit responses), and*Stationary (e.g. paperless office)*(Rank 3; 100% high benefit responses) and show weighted averages that correspond to *Very High* Return.

In fact, all areas under study have shown trends of *Very High* Returns as per Head of InstituteRespondents expect *Automation and integration Manpower (Teaching, Non-teaching, etc.) staff* and *Others*which have showed trends of *High* returns.

Thus, we can conclude that all areas under study have shown good amount of benefits / Return on Investments. Of these as per Head of Institute respondents *Communication*is the areas which gives maximum benefits.

Table 4.61: Extent of benefits or maximum Return on Investments on I.C.T.: A comparative view

Areas of Return/ Benefit	Ranks by Respondents		
	Technical Staff	Full-Time teaching Staff	Head of Institute
(a) Examination process	7	4	6
(b) Communication	1	2	1
(c) Manpower (Teaching, Non-teaching, etc.) staff	6	7	9
(d) Research	4	1	2
(e) Administration	5	6	4
(f) Decision making	8	8	7
(g) Stationary (e.g. paperless office)	2	9	3
(h) Information storage and access	3	5	5
(i) Automation and integration	9	3	8
(j)Others	10	10	10

***Refer Tables 4.58, 4.59 & 4.60**

Table 4.61 depicts a comparative view of responses (in the form of Ranks) from Technical Staff, Full-Time teaching Staff and Head of Institute w.r.t. Extent of benefits or maximum Return on Investments on I.C.T. for various areas related to Higher Technical Education Institutions. Table 4.61 has been derived from Refer Tables 4.58, 4.59 & 4.60.

As is evident from the Table 4.61, there are certain areas where responses of the three types of Respondents show similarity in opinions viz. *Communication*where Technical Staff and Head of Institute have Ranked it at No. 1 while Teaching Staff has ranked it at No. 2. Other areas that show such a trend are *Decision Making,* &*Information storage and access.*

But there are certain areas where there is a wide difference in opinions of the 3 respondent types. *Stationary (e.g. paperless office)* is an example of this where Technical Staff has ranked it at No. 2, while Full-Time teaching Staff has Ranked it at No. 9 and Head of Institute at No. 3. This means that while Technical Staff and Head of Institute think that ROI / Benefits are high in case of Stationary, but Teaching staff think otherwise.

Table 4.62: Extent of benefits or maximum Return on Investments on I.C.T.: A Integrated view

Areas of Benefit	Tech Staff			Teaching Staff			Heads of Institutions			Total (Weighted Avg. *Frequency)	Total respondents	Combined Avg. Wt.	Rank
	Weighted Avg	Frequency	Weighted Avg * Frequency	Weighted Avg	Frequency	Weighted Avg * Frequency	Weighted Avg	Frequency	Weighted Avg * Frequency				
Communication	4.18	111	464	4.66	332	1546	4.87	38	185	2195	481	4.56	1
Research	3.91	111	434	4.72	332	1566	4.82	38	183	2183	481	4.54	2
Automation and integration	3.23	111	359	4.57	332	1517	4.37	38	166	2042	481	4.25	3
Information storage and access	4.05	111	449	4.23	332	1404	4.71	38	179	2032	481	4.22	4
Administration	3.51	111	390	4.23	332	1406	4.76	38	181	1977	481	4.11	5
Examination process	3.33	111	370	4.30	332	1427	4.61	38	175	1972	481	4.10	6
Manpower (Teaching, Non-teaching, etc.) staff	3.36	111	373	4.20	332	1396	4.32	38	164	1933	481	4.02	7
Decision making	3.28	111	364	4.17	332	1383	4.53	38	172	1919	481	3.99	8
Stationary (e.g. paperless office)	4.07	111	452	3.78	332	1254	4.82	38	183	1889	481	3.93	9
Others	2.90	111	322	3.14	332	1044	3.61	38	137	1503	481	3.12	10

Table 4.62 depicts the overall opinion trends w.r.t. Extent of benefits or Return on Investments on I.C.T. received from various areas as per combined responses of all types of respondents. The purpose was to find the extent of Returns / benefits provided by various areas related to Higher Technical Education Institutions due to investments in I.C.T. in these institutions. Table 4.62 has been derived from Refer Tables 4.58, 4.59 & 4.60.

Looking at the Table 4.62, we see that Communication (4.56),Research (4.54) which fall under the category of Strongly Agree is ranked First and Second respectively.

It is interesting to see that *Information storage and access* (4.22),*Examination process*(4.10), *Stationary e.g. paperless office*(3.93) have landed at 4th, 6th and 9th Rank in the list. Though these have shown trends of Agree, still they have landed quite low in the list.

SUMMARY:

To summarize, the opinions w.r.t. Return on Investment / benefits from investment in I.C.T. vary between the different respondent types. Still, we can conclude that *Communication* is an area which has shown highest Return on Investment / benefits because of investment in I.C.T..*Research* is another area where Return on Investment / benefits is high. But in case of this particular area, the teaching staff and Head of Institute who understand the importance of research and even do it have actually understood the benefits from research and how I.C.T. has played a big role in enhancing research.

Overall, Communication and research have topped in the list of Benefits (ROI) with an Avg. weight of 4.56 and 4.54 showing that respondents Strongly agree. But presence of *Information storage and access* (4.22), *Examination process* (4.10), *Stationary e.g. paperless office* (3.93) low in the list makes us infer that digitization is still not fully done and that these have still not been able to reduce the monetary expenses involved in storage of data and saving huge amount of stationary spent in examination process.

4.5.5 BENEFITS PROVIDED BY IMPLEMENTATION OF I.C.T. IN HIGHER TECHNICAL EDUCATION INSTITUTION

Table 4.63: Benefits provided by implementation of I.C.T. in higher technical education institution as per Technical Staff views

Benefits	Responses as per Technical Staff							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Increase in admissions	1 (0.9)	2 (1.8)	12 (10.81)	25 (22.52)	71 (63.96)	111 (100)	4.47	1
Expand expertise base	0 (0)	1 (0.9)	13 (11.71)	34 (30.63)	63 (56.76)	111 (100)	4.43	2
Standardize processes	0 (0)	2 (1.8)	2 (1.8)	58 (52.25)	49 (44.14)	111 (100)	4.39	3
Effective communication between staff, students and other stakeholders	0 (0)	9 (8.11)	3 (2.7)	44 (39.64)	55 (49.55)	111 (100)	4.31	4
Knowledge Sharing	0 (0)	2 (1.8)	12 (10.81)	49 (44.14)	48 (43.24)	111 (100)	4.29	5
Efficiency and accuracy in delivery	1 (0.9)	10 (9.01)	9 (8.11)	38 (34.23)	53 (47.75)	111 (100)	4.19	6
Attract more students and expert faculty members	0 (0)	1 (0.9)	31 (27.93)	29 (26.13)	50 (45.05)	111 (100)	4.15	7
Simplification and decentralization decision making	0 (0)	10 (9.01)	13 (11.71)	38 (34.23)	50 (45.05)	111 (100)	4.15	8
Staff Skill development	0(0)	5 (4.5)	16 (14.41)	47 (42.34)	43 (38.74)	111 (100)	4.15	9
Maximize resource utilization including learning resources	10 (9.01)	3 (2.7)	4 (3.6)	42 (37.84)	52 (46.85)	111 (100)	4.11	10
Result delivery	0 (0)	2 (1.8)	11 (9.91)	72 (64.86)	26 (23.42)	111 (100)	4.1	11
Reduced need of direct attention	5 (4.5)	0 (0)	8 (7.21)	66 (59.46)	32 (28.83)	111 (100)	4.08	12

Benefits	Responses as per Technical Staff							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Increase variety and depth in research and innovation	2 (1.8)	9 (8.11)	1 (0.9)	66 (59.46)	33 (29.73)	111 (100)	4.07	13
Investment decisions	0 (0)	9 (8.11)	18 (16.22)	48 (43.24)	36 (32.43)	111 (100)	4	14
Strategic partnering with external institutions	0 (0)	12 (10.81)	19 (17.12)	58 (52.25)	22 (19.82)	111 (100)	3.81	15
Facility rentals for corporate training and online exams	6 (5.41)	8 (7.21)	17 (15.32)	54 (48.65)	26 (23.42)	111 (100)	3.77	16
Better co-ordination of activities	0 (0)	21 (18.92)	8 (7.21)	57 (51.35)	25 (22.52)	111 (100)	3.77	17
Identification of areas which are consuming time and money	4 (3.6)	11 (9.91)	9 (8.11)	71 (63.96)	16 (14.41)	111 (100)	3.76	18
Reduced labour costs	0 (0)	15 (13.51)	27 (24.32)	42 (37.84)	27 (24.32)	111 (100)	3.73	19
Reduction in teaching-learning costs	4 (3.6)	9 (8.11)	30 (27.03)	46 (41.44)	22 (19.82)	111 (100)	3.66	20
Understand strategic needs	0 (0)	10 (9.01)	33 (29.73)	61 (54.95)	7 (6.31)	111 (100)	3.59	21
Profit margin maximization and wealth creation	1 (0.9)	8 (7.21)	36 (32.43)	57 (51.35)	9 (8.11)	111 (100)	3.59	22
Reduced administrative costs	0 (0)	2 (1.8)	51 (45.95)	49 (44.14)	9 (8.11)	111 (100)	3.59	23
Brand Building	8 (7.21)	27 (24.32)	5 (4.5)	33 (29.73)	38 (34.23)	111 (100)	3.59	24
Reduced payback period	0 (0)	22 (19.82)	35 (31.53)	33 (29.73)	21 (18.92)	111 (100)	3.48	25
Understand changing environment and requirements	12 (10.81)	7 (6.31)	37 (33.33)	39 (35.14)	16 (14.41)	111 (100)	3.36	26

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.63 depicts a list of common benefits, which may be provided by implementing I.C.T.in Higher Technical Education Institutions, as per responses of Technical Staff. 111 responses were taken from this category of Respondents. Likert's 5-point scale having the following options of Strongly Disagree, Disagree, Can't Say, Agree and Strongly Disagree were used. Weightage was given to each of these options (1 to 5). Ranking was done for each of the listed items(benefits) based on Weighted Average calculated for each of these items. Ranking was then created to find which benefits are more prevalent and which are not as per Technical Staff's perception.

As per Technical Staff Respondent's views (Refer Table 4.63), *Increase in admissions* (Avg weight 4.47)has Ranked at No. 1 (86.48% Agree responses) and show weighted averages corresponding to *Strongly Agree*.

This is followed by *Expand expertise base (*Rank 2, Avg. weight 4.43; 87.39% Agree responses) and *Standardize processes*(Rank 3, Avg. weight4.39; 96.39% Agree responses) and show weighted averages that correspond to*Agree*.

Reduced payback period(Avg. weight-3.48; 48.65% Agree Responses &19.82% Disagree responses)and *Understand changing environment and requirements* (Avg. weight 3.36; 49.55% Agree Responses & 17.12% Disagree responses) are benefits that have been Ranked 25th and 26th respectively and land at the bottom of the list. Also these benefits show weighted average that correspond to Can't Say.

Thus, ignoring Can't Say responses, we find that both these benefits reveals that in case *Reduced payback period* the Agree responses (48.65%) are more than Disagree responses (19.82%). Similarly, in case of *Understand changing environment and requirements*, the *Agree* responses (49.55%) far exceeds *Disagree* responses (17.12%).

Table 4.64: Benefits provided by implementation of I.C.T. in higher technical education institution as per Full-Time Teaching Staff views

Benefits	Responses of Full-Time Teaching Staff							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Knowledge Sharing	0 (0)	1 (0.3)	9 (2.71)	75 (22.59)	247 (74.4)	332 (100)	4.71	1
Maximize resource utilization including learning resources	0 (0)	1 (0.3)	5 (1.51)	199 (59.94)	127 (38.25)	332 (100)	4.36	2
Effective communication between staff, students and other stakeholders	0 (0)	1 (0.3)	16 (4.82)	195 (58.73)	120 (36.14)	332 (100)	4.31	3
Attract more students and expert faculty members	0 (0)	1 (0.3)	19 (5.72)	194 (58.43)	118 (35.54)	332 (100)	4.29	4
Staff Skill development	1 (0.3)	2 (0.6)	14 (4.22)	201 (60.54)	114 (34.34)	332 (100)	4.28	5
Increase variety and depth in research and innovation	0 (0)	0 (0)	15 (4.52)	209 (62.95)	108 (32.53)	332 (100)	4.28	6
Brand Building	0 (0)	1 (0.3)	10 (3.01)	215 (64.76)	106 (31.93)	332 (100)	4.28	7
Standardize processes	0 (0)	0 (0)	15 (4.52)	209 (62.95)	108 (32.53)	332 (100)	4.28	8
Expand expertise base	0 (0)	7 (2.11)	11 (3.31)	206 (62.05)	108 (32.53)	332 (100)	4.25	9
Better co-ordination of activities	0 (0)	1 (0.3)	12 (3.61)	227 (68.37)	92 (27.71)	332 (100)	4.23	10
Increase in admissions	1 (0.3)	0 (0)	24 (7.23)	205 (61.75)	102 (30.72)	332 (100)	4.23	11
Simplification and decentralization decision making	0 (0)	2 (0.6)	19 (5.7)	213 (64.2)	98 (29.5)	332 (100)	4.23	12
Result delivery	0 (0)	1 (0.3)	18 (5.42)	220 (66.27)	93 (28.01)	332 (100)	4.22	13

Benefits	Responses of Full-Time Teaching Staff							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Efficiency and accuracy in delivery	0 (0)	7 (2.11)	21 (6.33)	209 (62.95)	95 (28.61)	332 (100)	4.18	14
Identification of areas which are consuming time and money	0 (0)	6 (1.81)	29 (8.73)	201 (60.54)	96 (28.92)	332 (100)	4.17	15
Understand strategic needs	0 (0)	7 (2.11)	27 (8.13)	207 (62.35)	91 (27.41)	332 (100)	4.15	16
Understand changing environment and requirements	0 (0)	4 (1.2)	41 (12.35)	196 (59.04)	91 (27.41)	332 (100)	4.13	17
Strategic partnering with external institutions	0 (0)	16 (4.82)	35 (10.54)	184 (55.42)	97 (29.22)	332 (100)	4.09	18
Profit margin maximization and wealth creation	0 (0)	6(1.81)	48(14.46)	198 (59.64)	80 (24.1)	332 (100)	4.06	19
Reduced payback period	10 (3.01)	2(0.6)	54(16.27)	177 (53.31)	89 (26.81)	332 (100)	4	20
Reduced administrative costs	19 (5.72)	0(0)	29(8.73)	203 (61.14)	81 (24.4)	332 (100)	3.98	21
Reduction in teaching-learning costs	19 (5.72)	6(1.81)	24(7.23)	195 (58.73)	88 (26.51)	332 (100)	3.98	22
Facility rentals for corporate training and online exams	17 (5.12)	7(2.11)	66(19.88)	151 (45.48)	91 (27.41)	332 (100)	3.88	23
Investment decisions	0 (0)	4(1.2)	153 (46.08)	86 (25.9)	89 (26.81)	332 (100)	3.78	24
Reduced need of direct attention	19 (5.72)	11(3.31)	149 (44.88)	55 (16.57)	98 (29.52)	332 (100)	3.61	25
Reduced labour costs	16 (4.82)	129(38. 86)	29 (8.73)	75 (22.59)	83 (25)	332 (100)	3.24	26

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.64 depicts a list of common benefits, which may be provided by implementing I.C.T.in Higher Technical Education Institutions, as per responses of Full-Time Teaching Staff. 332 responses were taken from this category of Respondents. Likert's 5-point scale having the following options of Strongly Disagree, Disagree, Can't Say, Agree and Strongly Disagree were used. Weightage was given to each of these options (1 to 5). Ranking was done for each of the listed items (benefits) based on Weighted Average calculated for each of these items. Ranking was then created to find which benefits are more prevalent and which are not as per Full-Time Teaching Staff's perception.

As per Full-Time Teaching Staff Respondent's views (Refer Table 4.64), *Knowledge Sharing*(Avg. weight 4.71)has Ranked at No. 1 (96.99% responses for Agree) and shows weighted averages corresponding to *Strongly Agree*.This is followed by *Maximize resource utilization including learning resources (*Rank 2, Avg. weight- 4.36; 98.19% Agree responses) and *Effective communication between staff, students and other stakeholders* (Rank 3, Avg. weight- 4.31; 94.87% Agree responses) and shows weighted averages that correspond to *Agree*.

*Reduced need of direct attention(*Avg. weight- 3.61; 46.09% Agree response; 9.03 % Disagree responses)and *Reduced labour costs (*Avg. weight- 3.24; 47.59% Agree response; 43.42% Disagree responses)land at the end of this list at 25th and 26th Rank but further analysis shows that respondents have given both of them more positive responses than negative responses.

Table 4.65: Benefits provided by implementation of I.C.T. in Higher technical education institution as per Head of Institute's views

Benefit	Responses of Head of Institute							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Knowledge Sharing	0 (0)	0 (0)	0 (0)	1 (2.63)	37 (97.37)	38 (100)	4.97	1
Effective communication between staff, students and other stakeholders	0 (0)	0 (0)	0 (0)	1 (2.63)	37 (97.37)	38 (100)	4.97	1
Reduction in teaching-learning costs	0 (0)	0 (0)	0 (0)	1 (2.63)	37 (97.37)	38 (100)	4.97	1
Increase in admissions	0 (0)	0 (0)	0 (0)	1 (2.63)	37 (97.37)	38 (100)	4.97	1
Attract more students and expert faculty members	0 (0)	0 (0)	0 (0)	2 (5.26)	36 (94.74)	38 (100)	4.95	2
Staff Skill development	0 (0)	0 (0)	0 (0)	2 (5.26)	36 (94.74)	38 (100)	4.95	2
Reduced administrative costs	0 (0)	0 (0)	0 (0)	2 (5.26)	36 (94.74)	38 (100)	4.95	2
Maximize resource utilization including learning resources	0 (0)	0 (0)	0 (0)	3 (7.89)	35 (92.11)	38 (100)	4.92	3
Brand Building	0 (0)	0 (0)	0 (0)	3 (7.89)	35 (92.11)	38 (100)	4.92	3
Expand expertise base	0 (0)	0 (0)	0 (0)	3 (7.89)	35 (92.11)	38 (100)	4.92	3
Efficiency and accuracy in delivery	0 (0)	0 (0)	1 (2.63)	1 (2.63)	36 (94.74)	38 (100)	4.92	3
Increase variety and depth in research and innovation	0 (0)	0 (0)	0 (0)	3 (7.89)	35 (92.11)	38 (100)	4.92	3
Better co-ordination of activities	0 (0)	0 (0)	0 (0)	4 (10.53)	34 (89.47)	38 (100)	4.89	4
Reduced labour costs	0 (0)	0 (0)	0 (0)	5 (13.16)	33 (86.84)	38 (100)	4.87	5

Benefit	Responses of Head of Institute							
	Strongly Disagree (1)	Disagree (2)	Can't Say (3)	Agree (4)	Strongly Agree (5)	Total	Weighted Avg.	Rank
Reduced need of direct attention	0 (0)	0 (0)	1 (2.63)	4 (10.53)	33 (86.84)	38 (100)	4.84	6
Identification of areas which are consuming time and money	0 (0)	0 (0)	1 (2.63)	5 (13.16)	32 (84.21)	38 (100)	4.82	7
Standardize processes	0 (0)	0 (0)	2 (5.26)	4 (10.53)	32 (84.21)	38 (100)	4.79	8
Strategic partnering with external institutions	0 (0)	0 (0)	1 (2.63)	7 (18.42)	30 (78.95)	38 (100)	4.76	9
Understand strategic needs	0 (0)	0 (0)	2 (5.26)	6 (15.79)	30 (78.95)	38 (100)	4.74	10
Simplification and decentralization decision making	0 (0)	0 (0)	1 (2.63)	9 (23.68)	28 (73.68)	38 (100)	4.71	11
Result delivery	0 (0)	0 (0)	3 (7.89)	6 (15.79)	29 (76.32)	38 (100)	4.68	12
Investment decisions	0 (0)	0 (0)	5 (13.16)	5 (13.16)	28 (73.68)	38 (100)	4.61	13
Understand changing environment and requirements	0 (0)	0 (0)	6 (15.79)	5 (13.16)	27 (71.05)	38 (100)	4.55	14
Profit margin maximization and wealth creation	0 (0)	1 (2.63)	6 (15.79)	7 (18.42)	24 (63.16)	38 (100)	4.42	15
Reduced payback period	0 (0)	1 (2.63)	12 (31.58)	7 (18.42)	18 (47.37)	38 (100)	4.11	16
Facility rentals for corporate training and online exams	0 (0)	5 (13.16)	12 (31.58)	7 (18.42)	14 (36.84)	38 (100)	3.79	17

Note: values outside brackets are indicative of Frequency (Number of respondents) and those inside the brackets indicate frequency in Percentage

Table 4.65 depicts a list of common benefits, which may be provided by implementing I.C.T.in Higher Technical Education Institutions, as per responses of Head of Institute. 38 responses were taken from this category of Respondents. Likert's 5-point scale having the following options of Strongly Disagree, Disagree, Can't Say, Agree and Strongly Disagree were used. Weightage was given to each of these options (1 to 5). Ranking was done for each of the listed items (benefits) based on Weighted Average calculated for each of these items. Ranking was then created to find which benefits are more prevalent and which are not as per Head of Institute's perception.

As per Head of Institute Respondent's views (Refer Table 4.65), *Knowledge Sharing*, *Effective communication between staff, students and other stakeholders*, *Reduction in teaching-learning costs*, *Increase in admissions* have same Weighted Averages and actually share the Rank No. 1*(*Avg. weight- 4.97; 100.00% responses for Agree)) and shows weighted averages corresponding to *Strongly Agree*.

Attract more students and expert faculty members, Staff Skill development, and *Reduced administrative costs*rank at No. 2*(*Avg. weight- 4.97; 100% responses for Agree).

*Facility rentals for corporate training and online exams (*Avg. weight- 3.79; 55.26% responses for Agree)ranks last but has weighted average corresponding to Agree.

Table 4.66: Benefits provided by implementation of I.C.T. in Higher technical education institution: A comparative view

Sr. No.	Item	Technical Staff	Teaching Staff	Head of Institute
1	Maximize resource utilization including learning resources	10	2	8
2	Standardize processes	3	8	17
3	Simplification and decentralization decision making	8	12	20
4	Reduced need of direct attention	12	25	15
5	Investment decisions	14	24	22
6	Result delivery	11	13	21
7	Enhanced public profile of institution (Brand Building)	24	7	9
8	Expand expertise base	2	9	10
9	knowledge Sharing	5	1	1
10	Efficiency and accuracy in delivery	6	14	11

Sr. No.	Item	Technical Staff	Teaching Staff	Head of Institute
11	Identification of areas which are consuming time and money	18	15	16
12	Attract more students and expert faculty members	7	4	5
13	Increase variety and depth in research and innovation	13	6	12
14	Understand strategic needs	21	16	19
15	Understand changing environment and requirements	26	17	23
16	Better co-ordination of activities	17	10	13
17	Effective communication between staff, students and other stakeholders	4	3	2
18	Staff Skill development	9		6
19	Strategic partnering with external institutions	15	18	18
20	Profit margin maximization and wealth creation	22	19	24
21	Reduced labour costs	19	26	14
22	Reduced administrative costs	23	21	7
23	Reduction in teaching-learning costs	20	22	3
24	Reduced payback period	25	20	25
25	Increase in admissions	1	11	4
26	Facility rentals for corporate training and online exams	16	23	26

(* Ref Table 4.63, 4.64 & 4.65)

Table 4.66 provides a comparative view in the responses of the three respondent types w.r.t. the benefits provided by implementation of I.C.T. in Higher technical education institution. It shows that in some cases the responses of Technical Staff are similar to those of Heads of Institutions, while in some other cases the responses of Technical Staff are similar to those to Full-Time teaching Staff. This may be because of difference in job profile and experience of each respondent type.This table has been derived from Tables 4.63, 4.64 & 4.65.

Table 4.67: Benefits provided by implementation of I.C.T. in Higher technical education institution: An Integrated view

Benefit	Combined Wt. Avg.	Rank
Knowledge Sharing	4.63	1
Effective communication between staff, students and other stakeholders	4.36	2
Maximize resource utilization including learning resources	4.35	3
Standardize processes	4.35	4
Increase in admissions	4.34	5
Attract more students and expert faculty members	4.31	6
Staff Skill development	4.30	7
Increase variety and depth in research and innovation	4.28	8
Result delivery	4.27	9
Simplification and decentralization decision making	4.25	10
Efficiency and accuracy in delivery	4.24	11
Investment decisions	4.20	12
Better co-ordination of activities	4.18	13
Brand Building	4.15	14
Identification of areas which are consuming time and money	4.12	15
Strategic partnering with external institutions	4.08	16
Understand strategic needs	4.07	17
Expand expertise base	4.02	18
Reduction in teaching-learning costs	3.99	19
Understand changing environment and requirements	3.98	21
Profit margin maximization and wealth creation	3.98	21
Reduced administrative costs	3.97	22
Reduced payback period	3.89	23
Facility rentals for corporate training and online exams	3.85	24
Reduced need of direct attention	3.81	25
Reduced labour costs	3.48	26

As is evident from Table 4.67, *Knowledge Sharing* (4.63) is the benefit which has been Ranked First overall showing Strongly Agree opinion of all respondents taken together.

Effective communication between staff, students and other stakeholders (4.36), *Maximize resource utilization including learning resources*(4.35), and *Standardize processes*(4.35) come at Ranks Second, Third, and Four respectively.

SUMMARY:

From above discussion we can summarize that Technical Staff give highest ranking to *Increase in admission* and *Expand expertise base* while they give least ranking to *Reduced payback period* and *Understand changing environment and requirements*. On the other hand, Full-Time teaching staff give *Maximum ranking to Knowledge sharing* and *Maximize resource utilization including learning resources* and least ranking to *Reduced need to direct attention* and *reduced labour cost*. Head of Institute have given highest ranking to *Knowledge Sharing and Effective communication between staff, students and other stakeholders* and least ranking to *Facility rentals for corporate training and online exams*.

Overall *Knowledge Sharing* (4.63) is the benefit which has been Ranked First overall showing Strongly Agree opinion of all respondents taken together while *Effective communication between staff, students and other stakeholders* (4.36), *Maximize resource utilization including learning resources*(4.35), and *Standardize processes*(4.35) come at Ranks Second, Third, and Four respectively.

In fact, there is no item which has been negatively responded by any type of respondents.

4.6 HYPOTHESIS TESTING

HYPOTHESIS 1:

H_0: There is No significant difference in availability of basic I.C.T. facilities for students in Higher Technical Educational Institutions located in Pune’s Urban areas and Rural areas.

H_1: There is a significant difference in availability of basic I.C.T. facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.

Table 4.68: Basic I.C.T. facilities available to students in Urban Institutions

Sr. No.	Basic Facilities	No. of Respondents (Urban)					Total Respondents	Weights	Wt. Avg.	Variance
		1	2	3	4	5				
1	PC	0	9	17	104	174	304	1355	4.46	1.34
2	Laptop	111	170	14	3	6	304	535	1.76	
3	Scanner	119	148	12	16	9	304	560	1.84	
4	Printer	49	119	14	98	24	304	841	2.77	
Total							1216	3291		

Note: Never- 1, Sometimes – 2, Can't Say- 3, Frequently – 4, and Very Frequently – 5

Table 4.68 depict the data availability of basic I.C.T. facilities to students in Urban regions.

Table 4.69: Basic I.C.T. facilities available to students in Rural Institutions

Sr. No.	Basic Facilities	No. of Respondents(Rural)					Total Respondents	Weights	Wt. Avg.	Variance
		1	2	3	4	5				
1	PC	0	4	0	62	65	131	581	4.44	1.55
2	Laptop	99	19	0	9	4	131	193	1.47	
3	Scanner	91	36	0	4	0	131	179	1.37	
4	Printer	45	59	0	27	0	131	271	2.07	
Total							524	1224		

Note: Never- 1, Sometimes – 2,Can't Say- 3,Frequently – 4,and Very Frequently - 5

Table 4.69 depict the data availability of basic I.C.T. facilities to students in Rural regions. The Mean Score is calculated for each option.

Testing of Hypothesis

Choosing Appropriate Test:

Sample Size n1=304 (> 30) and n2=131 (> 30)

As n > 30, large sample test, Therefore, **Z-test: two sample means** is used.

Calculating Value of Variance

Formula for calculating Variance:**Variance= Σ (x-Mean of x)^2 /n**

Where, x- value of item

n=number of items= 4

Variance for Sample 1 (Urban)= 1.34

Variance for Sample 2 (Rural)= 1.55

Using Hypothesized Mean Difference=0.5

Calculating Z use data analysis tool of Excel, we get:

Table 70: Calculating Z use data analysis tool of Excel

	Urban	Rural
Mean	2.6325	2.3375
Known Variance	1.34	1.55
Observations	4	4
Hypothesized Mean Difference	0.05	
Z	0.288235294	
P(Z<=z) one-tail	0.386583317	
z Critical one-tail	1.644853627	
P(Z<=z) two-tail	0.773166634	
z Critical two-tail	1.959963985	

<u>Manual calculation:</u>

$$z = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{\sigma_1^2}{n1} + \frac{\sigma_2^2}{n2}}}$$

Where, z- is z score

$\bar{x}_1, \bar{x}_2$ is Mean of Sample 1 (Urban) and Sample 2 (Rural)

μ_1,μ_2 is Mean of Population 1(Urban) and Population 2 (Rural)

σ_1^2,σ_2^2 is Variance of Sample 1 (Urban) and Sample 2 (Rural)

n_1, n_2 is Number of items in sample 1 and sample 2

mean of Urban sample $\bar{x}_1$	mean of Rural Sample $\bar{x}_2$
2.6325	2.3375

Difference between Mean of Urban Sample and Rural sample ($\bar{x}_1$-$\bar{x}_2$) = **0.295**

Level of Significance (μ_1-μ_2)=0.05

(Difference between Mean of Urban Sample and Rural sample) - Level of Significance= 0.245

Variance of Urban Sample σ_1^2	Variance of Rural Sample σ_2^2
1.34	1.55

n1=n2=4

$Variance_1/n_1$	$Variance_2/n_2$	Total
0.335094	0.386369	0.72

Root of [($Variance_1/n_1$)+($Variance_2/n_2$)
0.849389

z=0.288442

At 5% of Level of Significance, the calculated value for P (two-tail) is 0.773166634. This value of P is > 0.05.

This leads to acceptance of Null hypothesis (H_0) "**There is No significant difference in availability of basic I.C.T. facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas**".

$H_0: \mu_1 = \mu_2$

HYPOTHESIS 2:

H_0: Institution's I.C.T. security policy has NOT been able to secure I.C.T. infrastructure of the institution.

H_1: Institution's I.C.T. security policy has been able to secure I.C.T. infrastructure.

Testing the Hypothesis

One sample T-test is used as sample is more than 30 and is Nominal in nature. SPSS has been used to conduct the test.

To test the hypothesis, we asked the question: Rate the extent of success of the following factors in being able to reduce / prevent I.C.T. security lapse or attack: (1-lowest and 5-highest): Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets.

N	Mean	Std. Deviation	Std. Error Mean
111	2.95	1.034	.098

Test Value = 3					
T	df	Sig. (2-tailed) P	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
-.551	110	.583	-.054	-.25	.14

As the data is nominal and the sample size is above 30, we have, therefore, used t-test.

Since p value (.583) is >0.05 Null hypo "Institution's I.C.T. security policy has NOT been able to secure I.C.T. infrastructure and data assets of the institution" is accepted at 5% level of significance.

HYPOTHESIS 3:

H_0: I.C.T. security policy document created by the institute's Management is NOT displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.

H_1:I.C.T. security policy document created by the institute's Management is displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.

Testing the Hypothesis

We initially used Binomial test for testing the hypothesis as data is nominal and sample size more than 30. But, this test showed Type I error.

Therefore, one sample t-test is being used. SPSS has been used to conduct the test.

N	Mean	Std. Deviation	Std. Error Mean
435	1.57	.496	.024

Test Value = 51					
T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
				Lower	Upper
-2080.066	434	.000	-49.430	-49.48	-49.38

As p value (.0000) <.05 therefore Null hypothesis "I.C.T. security policy document created by the institute's Management is NOT displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune." is rejected.

SUMMARY

Looking at the analysis and findings, the researcher has come to the conclusion that all the objectives in the study have been successfully and deeply studied. Hypothesis has also been tested.

REFERENCES

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CHAPTER 5

FINDINGS, SUGGESTIONS

AND

SCOPE FOR FURTHER RESEARCH

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FINDINGS, SUGGESTIONS

AND

SCOPE FOR FURTHER RESEARCH

5.0. INTRODUCTION:

This chapter is aimed at presenting the important findings from the study. Subsequently, the conclusion drawn from the study and suggestions arising out of the study have been presented.

During the course of study and secondary data, in particular, it was found the previously published research material on this particular area of the study was very limited. A number of areas and aspects required wider and in-depth research. The scope for further research is, therefore, briefly discussed before concluding the chapter. For ready reference and convenience, table numbers of the study are given in brackets in the concerned paragraph of the chapter.

5.1. FINDINGS:

In this section, findings which were made in the previous chapters have been recapitulation in a short form.Four objectives and three hypotheses have been used for carrying an in-depth study on the subject. The fifth objective is part of suggestions as it aims to provide a theoretical model as solution for correcting some of the problems found in the ICT facilities as outcome of the study.

The researcher has analyzed the primary data to study the current status of implementation of I.C.T. infrastructure facilities and services and its security in Higher Technical Education institutions in Pune region. The researcher has done the assessment on the subject by collecting data and analyzing it according to 4respondent types namely I.C.T. support Staff, Full-Time Teaching Staff, Full-Time Students, and Heads of Institution.

Therefore, in this section we provide the summarized findings from these 4 respondents in Four parts viz. Part I: Findings from I.C.T. Technical Staff, Part II: Findings from Full-Time Teaching Staff, and Part III: Findings from Full-Time Students, and Findings from Heads of Institutions.

5.1.1 PART I: FINDINGS FROM I.C.T. TECHNICAL STAFF:

I.C.T. Technical Staff is the actual person who is responsible for setting-up the I.C.T. infrastructure, maintaining it and upgrading it from time to time as per requirements.It is also their responsibility to secure the I.C.T. infrastructure from physical damages as well as security compromises.

Data from I.C.T. technical Staff was analyzed on following points Total PCs, Norms followed for creating I.C.T. infrastructure, I.C.T. implementation support source, Number of I.C.T. Technical Staff employed in the institution, Availability Laptops, printers, etc. available to students and staff for use, Type of PCs and Servers used (Branded/ Unbranded), Software Type used the institution (Open-source, licensed, etc.), Speed of internet Connection, Type of Internet Connection, Purpose of using institution's I.C.T. infrastructure, ERNET services used by institution, Availability of Wi-Fi, Audit frequency, Maintenance of Internet usage logs, Drafted ICY policy in the institution and its display in the institution, Extent of satisfaction w.r.t. to I.C.T. services by the institution, Measures to improve user satisfactionExtent of satisfaction w.r.t overall I.C.T. infrastructure security, Extent of satisfaction w.r.t. overall I.C.T. Digital assets security, Level of I.C.T. security attacks encountered.Role in preparing I.C.T. Policy, Licensed Antivirus software available of PCs and Servers, Factors influencing increase in I.C.T. security attacks / lapses, Factors which help reduce / prevent I.C.T. security lapse or attack, Areas that need to be addressed to reduce / prevent I.C.T. security lapse or attack, Percentage of Annual Budget is set aside for I.C.T. and Actual expenditure Percentage made on New purchases / Up-gradation of I.C.T., &Areas providing benefits and maximum Return of Investments on I.C.T..

- All (100%) of the engineering institutions having various range of student intake havethe required or more number of PCs. Pharmacy institutions also showcase similar trends. Management institutes also depict a similar trend except for institutes having *More than 900 but less than 1200* enrolled students where only 16.7% institutes have required or more amount of Pcs.(Ref. Table 4.2).**The**

Management colleges which have higher number of enrolled students .i.e. more than 900 but less than 1200, in majority of cases have lesser number of PCs than required by AICTE.Looking at PC-to –Student ratio where the minimum ratio is not obtained in middle sized institutions means such institutions are defying even A.I.C.T.E. and DTE Norms.

- 85.6% institutions have used Vendor Support to setupI.C.T. infrastructure facilities while 42.3% have used Internal Staff resources to do so. Only 32.4% have used services of Independent specialist consultants. **Low use of Specialist services shows that educational institutions have still not been able to match or adopt the industry culture and specifications** w.r.t. I.C.T. implementation and its security. (Ref Table 4.3).

- 82.9% Technical Staff have stated that their institution's I.C.T.infrastructure facilities were created using A.I.C.T.E. Norms, DTE Norms was at 64.9%. Only 18% said they followed UGC norms (Refer Table 4.5). **This may be because UGC norms doesn't directly apply to individual colleges but on Universities. As Management and Engineering are reporting to AICTE and DTE as regulatory body, this might be the reason they are following AICTE and DTE norms more.**

- As per Technical Staff Respondent's views (Refer Table 4.7), PCs have been Ranked at No. 1 followed by Printers (Rank 2), Laptops (Rank 3), Scanners (Rank 4). This implies that according to Technical Staff, the institutions where they are serving PCs are most available for users.Deeper analysis shows that Technical Staff point out that PCs are 100% Frequently available along with Printers which are 77.48% frequently available. In contract, Laptops are 62.16% Never available and Scanners are 85.59% Never available.**In institutions PCs are available for use of students and staff frequently. Though Printers, laptops and Scanners might be available in the institute but students are not allowed to use them.**

- Only 3.6% Technical Staff respondents have opined that institute is using Non-Branded PCs and Servers. 49.5% respondents opined that their institution is using Branded PCs and Servers. These are good indications. **But 46.8% say**

that their institution is using a mix of Branded and Non-Branded Servers and PCs. (Ref Table 4.10).**It is not clear regarding what is the proportion of Branded PCs and Servers in this. It must be understood that if percentage of Non-branded ones is more then it means that there is lot of compromise with security and safety of data as failure rate of non-branded machines is always a big question.**

- As per responses of Technical Staff w.r.t what type of software are used in their institute, *Licensed Software* have been Ranked at No. 1 (most frequently available and used) followed by *Open-Source Software* (Rank 2), *Trial-version / Unlicensed Software* (Rank 3), *In-house developed software* (Rank 4) by Technical Staff.Ignoring Neutral / Can't Say responses, 88.20% technical Staff say that Licensed Software are Frequently used. This is followed by *Open-source software* (71.17%) and *Trial-version software* (56.76%).In contract to this 70.27% respondents say that *In-house developed software* are Never used in their institution. (RefTable 4.12). **This implies that according to Technical Staff, the institutions where they are serving, most of the software being used are licensed versions. Open-Source software which do not need any type of licensing are also much in use. Also Institutions like engineering and Management (MCA) are not using the talent and skills of their staff and students to develop software in-house.**

- As per Technical Staff's responses *10 Mbps to 15 Mbps* (45%) was the Internet Speed (bandwidth) that most Institutions were using whereas *15 Mbps and above* (4.5%) was least been used. (Ref Table 4.16).**All institutions have appropriate amount of Internet Bandwidth.**

- Broadband(51.35%) and Leasedline (48.65%) internet connections are most in use. Various factors for this include ease of installation and use, pricing, etc.(Ref Table 4.17)**All institutions have some type of commonly used internet connection.**

- As per Technical Staff Respondent's views (Refer Table 4.18) w.r.t. purpose of use of ICT infrastructure facilities provided in the higher technical education institutes, *Emails* have been Ranked at No. 1 followed by *Lecture Preparation*

(Rank 2), and *View Online lectures* (Rank 3). This implies that most of the technical staff themselves mostly use their institutions I.C.T. infrastructure for Email. Job Searching (Rank 12) at last which means users do not search for Jobs using their institutions I.C.T. infrastructure. 99.1% Technical Staff respondents say that *Email* isFrequently used which is followed by *Lecture Preparation* (86.5%). In contract to this, 61.3% respondents say that *Listening to songs and Videos* and *Job searching* (49.5%) is not done by the users using the institution's I.C.T. infrastructure.**Users of I.C.T. use I.C.T. infrastructure of institution for Lecture Preparation and Viewing Online structure and they don't use it for recreation / entertainment work like Listening to Songs and Videos or for Job Searching.**

- As the Table 4.22 depicts, 18% of Technical Staff respondents say that their institution is connected to ERNET while 48.6% respondents say that their institution is not connected to ERNET. **Majority of institutions are Not Connected with ERNET** (48.6%).

- 86.49% I.C.T. Technical staff respondents say that their institution has Wi-Fi network installed while only 13.51% respondents say that their institution doesn't have Wi-Fi network installed.(Ref Table 4.23). **Majority of institutions have Wi-Fi network. This is good indication but it is not clear whether Wi-Fi internet availability is allowed for students or it is just limited to usage by Staff and Management.**

- As per Technical Staff Respondent's views w.r.t. Satisfaction with certain I.C.T. services (Refer Table 4.24), *Internet services through wired network* has Ranked at No. 1 followed by *Maintenance / Technical support* (Rank 2), and *Communication facilities (email, SMS, alert messaging, etc.)*(Rank 3) and show weighted averages that correspond to *Satisfied*. Administration software, Storage and Backup utilities Rank at 7th and 8th. Of these, *Storage and Backup Utilities* show weighted averages corresponding to Neutral. Further analysis shows that in case of *Storage and Backup utilities* the number of respondents who are *satisfied* (44.14%) far exceeds the number of respondents that are dissatisfied (23.42%). This implies that respondents are actually satisfied with it. **Thus, there are no**

I.C.T. services or facilities offered by institutions with whom users are not satisfied as per Technical Staff.

- As per responses of Technical Staff w.r.t. measures for improving user satisfaction, *Increase in number of technical support staff* (87.4%) is the most required measure whereas Provide after-hour lab facility (18%) is one of the least required measure for satisfaction enhancement as per Technical Staff.(Ref Table 4.28). **Technical Staff has greatly emphasized on training of technical staff and also increasing their numbers in the institutions. They have also asked for replacing old PCs and Servers.**

- Weighted averages from Technical Staff responses suggest that these respondents are *Satisfied(4.01)* overall I.C.T. infrastructure security. In fact91.89% of Technical Staff respondents have shown positive response. (Ref Table4.30). **Majority of Technical Staff are *Satisfied* overall I.C.T. infrastructure security.**

- Weighted averages from Technical Staff responses (3.76) suggest that these respondents are Satisfied with overall I.C.T. digital assets security provided by their institution. . In fact 79.3% of Technical Staff respondents have shown positive response. (Table Ref- 4.32). **Majority of the Respondents are Satisfied with overall I.C.T. digital assets security provided by their institution.**

- The highest weighted Average is for Low intensity attacks (3.8) followed by Mild (2.43) and (1.88).In case of low intensity attacks the highest frequency of occurrence is at 4 with a response (43.2%). In case of Mild intensity attacks the highest frequency is at 2 with a response frequency (38.7%). In case of High intensity attacks the highest frequency is at 1 with a response frequency (47.7%) (Ref Table 4.34).**This means that though mild and high attacks are also occurring but it is the Low Intensity attacks, which even though might not do lot of destruction or losses, but are most frequently occurring out of the three and their occurrence is nearly moderately high.**

- As per Technical Staff's responses, we find that majority of these respondent's role in Policy Making is confined to *Consultative* (82.9%) (Ref- Table 4.40). **This means that Technical Staff mostly give consultation but they are not the final decision makers even though they have best technical and operational knowledge in this area.**

- 33.3%Technical Staff state that their institute doesn't have a formal I.C.T. Up-gradation policy while only 18.0% say it is present (Ref Table-4.41).**Majority Technical Staff says their institute doesn't have a formal I.C.T. up-gradation policy.**

- As is evident from the Table 4.43, Technical Staff (53.2%) state that *All Servers* have antivirus installed on them whereas 43.2% state that *Few Servers* have antivirus installed on them. This means that **majority respondents state in their institution all servers are protected by antivirus but considerable number them also state that in their institutions antivirus is installed only on few servers.**

- Table 4.43states that 30.6% Technical Staff state that *All PCs* have antivirus installed on them whereas 69.4% state that *Few PCs* have antivirus installed on them. This means that in **majority institutions All PCs used by students and staff members are not protected and this is a great danger to the security of the data.**

- The factors namely *Lack of Technical staff*(4.43), *Carelessness of users*(4.38), *Lack of equipment / technology / software in the institution to avoid I.C.T. attacks* Ranked I, II and III and showed weighted average corresponding to High Role.*Lack of hardware / data ,etc. disposal policy, Lack of Content management, Lack of Data Governance (Management/storage/dispersion) policy*, and *Lack of fixation of responsibility and liabilities on users* which are ranked at 14th, 15th, 16th and 17th rank show weighted averages which correspond to neutral responses from Technical Staff respondents. Further analysis of these factors reveal that in case of *Lack of Technical staff (92.8%), Carelessness of users* (83.8%), *Lack of equipment / technology / software in the institution to avoid I.C.T. attacks (88.2), Lack of hardware / data, disposal policy (9.55%), Lack of*

Content management (28.83%), Lack of Data Governance (Management/storage/dispersion) policy(40.54%), and *Lack of fixation of responsibility and liabilities on users(41.44%)* Technical Respondents have stated that these factors have a High Role in committing of I.C.T. Security attacks. (Ref Table 4.45). **Top most factor which play major role in committing of I.C.T. security attacks include Lack of Technical staff, Carelessness of users, *Lack of equipment / technology / software in the institution to avoid I.C.T. attacks. Lack of Content management, Lack of Data Governance (Management/storage/dispersion) policy,* and *Lack of fixation of responsibility and liabilities on users* are at the bottom of the list.**

- **(**Ref-Table 4.46)As per Technical Staff responses, *Antivirus, firewall, auto-updates, etc.* (4.5; 90.99% high role responses) Ranks at No. 1, and comes under the category of Very High role in reducing / preventing I.C.T. security attacks. This is followed by *Technical staff able to manage I.C.T. infrastructure and its security* (4.26; 78.38% high role responses;) and *Educating of staff and students about I.C.T. laws and Best Practices* (3.77; 67.57% high role responses) which come in the category of High Role. *Security audit able to find gaps in I.C.T. security* (2.66; 13.51% high role responses; 39.64% low role responses) shows that it falls in Average Role category and finds its place at the end of the list.***Antivirus, firewall, auto-updates, etc, Technical staff able to manage I.C.T. infrastructure and its security,* and *Educating of staff and students about I.C.T. laws and Best Practices* are the top ranked factors which play major role in reducing / preventing I.C.T. security lapse or attack as per Technical Staff.**

- As per Technical Staff, *Stringent Penalties* (74.8%) is the most important Areas that need to be addressed to improve I.C.T. security in the institutes. This is followed by *Identification and blocking loopholes in security* (73.0%) and *User Awareness about cyber laws*(72.0%). Changes in routines, beliefs and informal norms used in the organization(44.1%) is the least important area.(Ref Table 4.49). **Technical staff's solution for improvement in I.C.T. security are mainly aimed at users and include penalties as well as user education.**

- Technical Staff have given highest responses (30.6%) to *15% to 20%of annual budget is set aside for I.C.T.*(Ref- Table4.52). But on an average only 16.7% of Annual Budget is set aside for I.C.T. (Ref- Table 4.53) as per Technical Staff. **The percentage of annual budget set aside for I.C.T. is quite low as compared to recurring and non-recurring annual costs related to I.C.T.. Very little is left for up-grading hardware and for purchasing new licensed software. The avg. I.C.T. budget is only 16.7% of total annual budget.**

- As per Technical Staff, the highest responses have been received by (ignoring *Can't say* responses*)40% to 60% of sanctioned I.C.T. budget actually utilized* (27.9%).(Ref Table 4.54)On an average 50.28% of the budget set aside for I.C.T. is actually used. **The actual spending on I.C.T. is very low as compared to what has been set aside in the annual budget.**

- 83.8% Technical Staff have said that they agree that "Investment in I.C.T. is Every penny Worth".(Ref- Table 4.56). **Majority of technical staff understand that investment in I.C.T. infrastructure is good for the educational institution.**

- As per Technical Staff Respondent's views (Refer Table 4.58), *Communication* (4.18) with 90.09% positive responses has Ranked at No. 1 followed by *Stationary (e.g. paperless office)* (Rank 2, 4.07) with 76.58% positive responses, *and Information storage and access* (Rank 3, 4.05) and show weighted averages that correspond to *High* Returns on Investment.

  Areas like *Manpower (Teaching, Non-teaching, etc.) staff, Examination process, Decision making, Automation* and *integration,* and *Others* depict weighted averages which point out towards Neutral responses. Ignoring Neutral responses, further analysis reveals that in case of *Manpower (Teaching, Non-teaching, etc.) staff* the responses for *High* return (42.34%) are more than those for *Low* (11.71%).

  In case of *Examination process,* the responses for *High* return (52.25%) are more than those for *Low* returns (23.42%). In case of *Decision making,* the responses for *High* return (28.83%) are more than those for *Low* returns (11.71%). In case of *Automation* and *integration,* the responses for *High* return (36.04%) are more than those for *Low* returns (14.41%). **This indicates that technical Staff feels that there is positive benefit / Return from Investment in I.C.T.especially in the field of Communications and Savings on Stationary.**

- As per Technical Staff Respondent's views regarding Benefits Provided by I.C.T. (Ref Table 4.63), *Increase in admissions* (Avg. weight 4.47, 86.48% positive responses towards agreement)has Ranked at No. 1 and show weighted averages corresponding to *Strongly Agree*.

  This is followed by *Expand expertise base (*Rank 2, Avg. weight 4.43, 87.39% positive responses towards agreement) and *Standardize processes* (Rank 3, Avg. weight 4.39, 96.39% positive responses towards agreement) and show weighted averages that correspond to *Agree*. *Reduced payback period* (Avg. weight-3.48)and *Understand changing environment and requirements* (Avg. weight 3.36) are benefits that have been Ranked 25th and 26th respectively and land at the bottom of the list. Ignoring Neutral/ Can't say, further, analysis of these 2 benefits reveals that in case *Reduced payback period* the Agree responses (48.65%) are more than Disagree responses (19.82%). Similarly, in case of *Understand changing environment and requirements,* the *Agree* responses (49.55%) far exceeds *Disagree* responses (17.12%).**Colleges have been using I.C.T. as a factor for Increase in admission. They want to attract students by showing that they have internet, Wi-Fi facility and computer labs. Standardization of day-to-day institutional processes is also an area which institutions are looking at using the help from I.C.T..**

5.1.2 PART II: FINDINGS FROM FULL-TIME TEACHING STAFF:

Full-Time Teaching is one of the main end-users of I.C.T. infrastructure and facilities in institutions of Higher Technical Education. Today's higher education systems is gradually moving from Blackboard to Electronic presentation skills. Thus, their opinion regarding various facets of I.C.T. infrastructure and services offered in institution of service is quite important.

For this type of respondent,primary data was collected using questionnaires from 332 respondents who were working as full-time paid teaching staff at Professional higher technical education institution running A.I.C.T.E. approved course and teaching only A.I.C.T.E. approved course.

In this case the data collection collected and analyzed based on following points (excluding certain general institute-related information) viz. Total Number of Full-time enrolled Students (including all years), Courses Conducted (A.I.C.T.E. Approved only), Total Number of Full-time Teaching Staff members, Total Number of PCs in the institution for the said course, Availability Laptops, printers, etc. available to students and staff for use, Type of PCs and Servers available in the institution, Software Type used the institution (Open-source, licensed, etc.), Norms followed for creating your I.C.T. infrastructure., Purpose of using institution's I.C.T. infrastructure, Extent of satisfaction w.r.t. to I.C.T. services by the institution, Measures to prove improve user satisfaction., Extent of satisfaction w.r.t overall I.C.T. infrastructure security, Extent of satisfaction w.r.t. overall I.C.T. Digital assets security, Level of I.C.T. security attacks encountered, Success factors influencing reduction / prevention of I.C.T. security lapse, Areas to be addressed to improve I.C.T. security, Percentage of Annual Budget is set aside for I.C.T. and Actual expenditure Percentage made on New purchases / Up-gradation of I.C.T., Whether investment in I.C.T. infrastructure is every penny worth spent, Areas providing benefits and maximum Return of Investments on I.C.T.,

- As per Full-time Teaching Staff,A.I.C.T.E. Norms (71.7%) is most followed norm but DTE Norms (18.7%) are least followed. (Ref- Table 4.5).

- As per Full-Time Teaching staff (Ref-Table 4.8), PC (4.46) have ranked FIRST, followed by Printer (3.57), Scanner (2.75), and Laptop (2.69).Here, PCs score 95.20% positive responses for frequently used. But Scanner's score for negative response forfrequently used is 53.30% and Laptop's negativeresponse for frequently used is 59.90%.**Teaching Staff have highlighted that though PCs are frequently available but Scanners and Laptops are not available to users (here Teaching Staff) for use.**

- As per Full-Time Teaching Staff, (Ref- Table 4.10), most commonly used PCs and Servers are Branded(73.5%). Only 0.6% are non-branded. **Teaching Staff have opined that most institutions are Branded.**

- As per Full-Time Teaching Staff, (Ref- Table 4.13) *Licensed Software* (4.54) are ranked FIRST with 96.69% positive responses for Frequent usage. *Open-source software* (3.11) are at SECOND rank with 49.70% positive responses for Frequent usage. *Trial version software* (2.89) are at THIRDrank with only 39.46% positive responses for Frequent usage. **Teaching staff have opined that though licensed software are mostly used followed by open-source software but higher education institutions are under-utilizing their talent by not developing software in-house. Approx. 40% usage of Trial Version software is also quite worrying for the security point of view.**

- As per Full-Time Teaching Staff (Ref- Table 4.19), *Research Work* (4.46) is Ranked FIRST as most frequently used I.C.T. services with 91.87% positive responses for frequently used followed by Email (4.38) with 86.45% stating that they frequently use it.. *Job Searching* and *Listening to Songs and Videos* are at bottom of the list with only 6.93% and 7.83% frequent used responses respectively for them. **According to Teaching Staff, they use I.C.T. infrastructure for *Research Work* and *Emailing* mostly and refrain from using institution's I.C.T. for personal work like *Job Search* and *Listening to songs and videos*.**

- As per Full-Time Teaching Staff views w.r.t. satisfaction with certain I.C.T. services and facilities (Refer Table 4.25), they are most Satisfied withCommunication facilities (Rank FIRST) with 75.30% giving positive responses for Satisfaction. Internet services through wired network (Rank SECOND) has attained 91.87% positive responses for satisfaction. Maintenance / Technical support has attained THIRD rank with 84.04% positive responses for satisfaction.Ignoring neutral responses, we find that I.C.T. Security policies and Security facility &Storage and Backup utilities which are at the bottom of the list and have attained only 24.10% and 26.51% positive responses for satisfaction. But dissatisfaction for these two are only 3.25% and 2.92% respectively. **According to Full-Time Teaching Staff, they are most satisfied with *Communication facilities* and *Internet Services through Wired Network*. Though*Security policies and Security facility*& S*torage and Backup utilities***

landed at the bottom of the list but still the majority of Teaching staff (ignoring neutral responses) have shown satisfaction with them.

- Full-Time Teaching staff have strongly opined that Antivirus(93.1%) if installed on PCs and Servers in the institution will really help in increasing user satisfaction among them. This is followed by ERP and other software used for teaching-learning (87.7%). The third important factor is Increase in number of technical support staff (83.4%). Replace old PCs, laptops, etc. (69.9%) is at the bottom of the list (Refer Table 4.28). **This means that Full-time Teaching Staff really feels the absence of Antivirus on PCs in the institute. They also feel that ERP usage will help in better administration and presence of other Teaching-learning software will help in improving teaching process. They also feel the absence of qualified I.C.T. technical staff in the institute as user's PCs and network might not be repaired on time. They also feel that they should get representation in developing I.C.T. security policy and this updation should be done more frequently. Old PCs and Servers, etc. should also be replaced. As all these factors have got more that 50% YES responses so this means that this is the call of the majority of Teaching staff responses and, thus, can't be ignored.**

- Full-time Teaching Staffw.r.t. overall I.C.T. infrastructure security are overall Satisfied (3.87) with 81.63% respondents showing positive responses towards satisfaction. (Ref- Table- 4.30).**Full-Time Teaching Staff is on a average satisfied with overall I.C.T. infrastructure security in their higher technical education institution.**

- Full-Time Teaching Staff w.r.t. overall I.C.T. Digital assets security are overall Satisfied (3.78) with 75.30% respondents showing positive responses towards satisfaction. (Ref- Table- 4.32).**Full-Time Teaching Staff is on a average satisfied with overall I.C.T. Digital assets security in their higher technical education institution.**

- As per Full-Time Teaching Staff, The most frequently occurring I.C.T. attacks are Low intensity attacks (1.91) followed by Mild (1.45) and (1.36).(Ref- Table 4.35) This means that **as per Full-Time Teaching Staff though Low, mild and**

high attacks are also occurring but their frequently occurring is very low. Of the three it is the Low intensity attacks which is most occurring and is occurring at moderately low rate. Mild and High intensity attacks are occurring but at Low occurrence rates as compared to Low Intensity ones.

- As per Full Teaching staff, 38.3% say that their institution doesn't have I.C.T. up-gradation policy while only 23.5% say it is present (Ref- Table- 4.45). **Ignoring Neutral responses, majority Full-Time Teaching Staff say that their institution doesn't have a formal I.C.T. up-gradation policy.**

- W.r.t factors which might play a major role in reducing / preventing I.C.T. security lapse or attack, as per Full-Time Teaching Staff responses, *Technical staff able to manage I.C.T. infrastructure* and its security (3.29; 50.6% High role responses) is ranked First, followed by *Educating of staff and students about I.C.T. laws and Best Practices* (3.27; 54.2% high role responses), and *Physical security of campus / building like CCTV, biometric access controls* (3.08; 35.8% high role responses) at the Second and Third Rank respectively. All these fall in the category of *Average Role*. *Institution's I.C.T. security policy is able to secure I.C.T. infrastructure and data assets* (2.23; 11.4% high role responses) comes at the bottom of the list falls in the Low Role category. (Ref Table- 4.47). **As per Full-Time Teaching Staff, Technical staff able to manage I.C.T. infrastructure, Educating of staff and students about I.C.T. laws and Best Practices, and Physical security of campus / building like CCTV, biometric access controls can play an average role in preventing I.C.T. attacks. They don't have much faith in Institution's I.C.T. security policy as an instrument to secure I.C.T. infrastructure and data assets.**

- W.r.t. Areas to be addresses to improve I.C.T. security in the institutes, Full-Time Teaching Staff have given highest*Yes* responses to *User Awareness about cyber laws* (YES: 87.65%) followed by *Train users to identify I.C.T. security risks* (YES : 86.4%). *Stringent penalties* (YES: 74.1%) is least preferred area.(Ref table 4.49)**As per Full-Time Teaching Staff, most important areas to improve I.C.T. Security is User Awareness about Cyber Laws and Train users to identify I.C.T. security risks. They do advocate Stringent Penalties**

(which might be for carelessness in carrying out duty by employees) but this is the last thing to do according to them.

- According to Teaching Staff, (ignoring Can't say responses) 9.9% have stated that 5% to 10 % of annual budget is set aside for I.C.T.. 7.5% respondents state that 15% to 20%of annual budget has been set aside for I.C.T.. Only 0.6% respondents state that 20% and above of annual budget is set aside for I.C.T. (Ref Table 4.52). But on an average only 19.88% of Annual Budget is set aside for I.C.T. (Ref- Table 4.53) as per Teaching Staff.**As compared to estimated recurring and Non-recurring expenses regarding I.C.T., only 0.6% respondents stating that 20% and above of annual budget is set aside for I.C.T. is too low and means that even though institutions are charging development fee from students they are not investing it in I.C.T. infrastructure.The average as per technical staff is only 19.88%.**

- As per Teaching Staff (ignoring Can't Say responses), the highest responses have been received by *20% to 40 % of sanctioned I.C.T. budget* (14.2%). 6.9% say their institute uses . 40% to 60%of sanctioned I.C.T. budget. Only 0.3% say that their institution is using 80% and above of sanctioned I.C.T. budget. (Ref Table 4.54).**Only 0.3% institutions using 80% and above of allocated for I.C.T. is a very critical issue. Though provision has been made in budget but these funds are lying unutilized. Thus, users have to work on old PCs and the network is also not ready to handle ever increasing security threats.**

- As per Teaching Staff, 87.95% of these respondents have given positive response for "Investment in I.C.T. is every Penny Worth". Of these 16.57% say that they Agree with it while 71.39% say that they Strongly Agree with it. (Ref Table 4.56). **Majority of Full-Time Teaching Staff Agree (87.95%) that "Investment in I.C.T. is every Penny Worth". This means that they known and understand the importance of I.C.T. in academics and are very sure about its positive outcomes.**

- As per Full-Time Teaching Staff, Research (4.72; 97.6% agree responses) and Communication (4.66; 96.7% agree responses) have given highest benefits or maximum Return of Investments on I.C.T. and have Ranked FIRST and

SECOND. *Examination process* lands at FOURTH rank with 96.39% positive responses. Stationary (e.g. paperless office) is at the bottom of the list with only 50.30% positive responses. In fact there is no item in the list which has received negative responses from the Teaching Staff respondents. (Ref Table 4.59) **Majority of Full-Time Teaching Staff agree that Research and Communications are areas where maximum benefits have been attained by investing in I.C.T.. But, though,the responses for Stationary are positive but approx. 50% is quite low. This means that as per Teaching Staff even after introduction of I.C.T., the academic institutions are still not able to cut-down the spending on Stationary which might be for examination, record keeping, etc.**

- As per Full-Time Teaching Staff, *Knowledge Sharing* and *Maximize resource utilization including learning resources* are the benefits which Rank at FIRST and SECOND position in the list of Benefits provided by implementation of I.C.T. in higher technical. They have attained 96.99% and 98.19% positive AGREE responses respectively.

  Reduced need of direct attention with 46.08% positive Agree responses and *Reduced labour costs* with 47.6% positive responses for Agree come at the last of the list.(Ref Table- 4.64)**We can thus conclude that Teaching Staff doesn't think that introduction of I.C.T. in higher technical educational institutions have benefited with introduction of I.C.T. in the field of reduction of direct attention and Reduction in labour costs.**

5.1.3 PART III: FINDINGS FROM FULL-TIME STUDENTS:

Full-Time Students constitutes the majority part of the end-users of I.C.T. infrastructure and facilities in institutions of Higher Technical Education. It is these students which form the majority of users of I.C.T. infrastructure in any Higher Technical Institution. They use the machines in the Computer labs. They give presentations and lectures using PPT presentations etc. In fact it is these students who are the customers of the institution and the biggest critics of facilities offered by these institutions. Thus, their opinion regarding various facets of I.C.T. infrastructure and services offered in institution of service is quite important.

For this type of respondent type of primary data was collected using questionnaires from 435 respondents who were enrolled as Full-time Students at Professional higher technical education institution running A.I.C.T.E. approved course and teaching only A.I.C.T.E. approved course.

In this case the data collection collected and analyzed based on following points (excluding certain general institute-related information) viz. Total Number of Full-time enrolled Students (including all years), Courses Conducted (A.I.C.T.E. Approved only), Total PCs, Availability Laptops, printers, etc. available to students and staff for use, Software Type used the institution (Open-source, licensed, etc.), Purpose of using institution's I.C.T. infrastructure, Extent of satisfaction w.r.t. to I.C.T. services by the institution, Extent of satisfaction w.r.t overall I.C.T. infrastructure security, Extent of satisfaction w.r.t. overall I.C.T. Digital assets security, Identify I.C.T. security lapses, Areas for improvement in I.C.T. security.

- As per Full-time Student Respondent's views (Refer Table 4.9), *PCs* have been Ranked at No. 1 (93.1% frequently available for use) followed by *Printers* (Rank 2; 34.2% frequently available for use), *Scanners* (Rank 3; 90.6% frequently not available for use), *Laptops* (Rank 4; 91.7% frequently not available for use). This implies that according to Full-time Students, the institutions where they are studying, PCs are most available for users. Deeper analysis shows that Printers, Scanners and Laptops have received negative responses for availability at 65.5%, 90.6% and 91.7%. (Ref Table- 4.6). **As per Full-Time Students, PCs are available for their use at their educational institute, but on the other hand, Printers, Scanners and Laptops are not available for use for students. The institution might be owning these equipment but they don't allow students to use them.**

- As per Full-Time student responses with regards to type of software available in institutions (Ref Table 4.14), most frequently available is Licensed Software with 72.90% respondents giving Positive response for Frequently available. This is followed by Open-Source Software (76.80% positive responses). In-house software are at the bottom of the list where only 4.80% respondents have given positive responses for frequently available. Students have also said that trial-version software are also quite frequently used with 77.80% positive responses for frequently available.**As per Full-Time Students responses, Licensed software are the most commonly available software type followed by Open-source. They have also suggested that Trial version software are very commonly used. This is not good from both legal and I.C.T. security point of view. Also, their response points out those institutions are neither developing nor using in-house developed software. This is waste of talent and experience of teaching staff and students (in particular those belonging to Computer related courses).**

- As per Full-Time student responses with regards to purpose for which they use their institution's I.C.T. infrastructure (Ref. Table 4.20), the most frequent one is Email (Rank FIRST) with 90.11%positive responses for frequent use. This is followed by Lecture and practical sessions (Rank SECOND) with 79.31% positive responses for frequently used. Social Networking (Rank THIRD) 77.24% positive responses for frequently used.

  As per Full-time student responses we find that, Presence of Email on Rank 1st and Social Networking on Rank 3rd on one hand while View Online Lectures and Vocational Training appearing at 11th and 12th Ranks respectively which means Students don't use I.C.T. infrastructure for academic purposes or for self-development. The Student's usage pattern depicts that students are more inclined towards entertainment and socializing and that academics is their second preference w.r.t. using their institute's I.C.T. infrastructure.

- As per Full-Time Student Respondent's views regarding satisfaction with certain I.C.T. services (Refer Table 4.26), *Communication facilities (email, SMS, alert messaging, etc.)* has Ranked at No. 1 (84.6% Satisfied responses) followed by *Internet services through wired network* (Rank 2; 62.8% Satisfied responses) and show weighted averages that correspond to Satisfied. *Academic application software* (Rank 3;60.5% Satisfied responses) and *Internet services through Wi-Fi* (Rank 4;46.4% Satisfied responses) show weighted averages that correspond to *Neutral*. *Storage and Backup utilities* and *Administration software* Rank at 7th and 8th also show weighted averages corresponding to Neutral. Further analysis shows that in case of *Storage and Backup utilities* the number of respondents who are Dissatisfied (53.80%) far exceeds the number of respondents that are Satisfied (37.20%). This implies that respondents are actually Dissatisfied with it. **Full-Time Students are not satisfied with Storage and back-up utilities and Administration Software. This means that institutions especially the big ones should build dedicated data storage facilities including Storage Area Networks.**

- As per Full-Time Student Respondent's views regarding Measures to improve User Satisfaction w.r.t. I.C.T. Services provided by Institutions, *Anti-virus* (92.2%) is most required. This is followed by *Increase Internet bandwidth and making available on all PCs*(91%) and *Training of Technical support staff* (78.2%).*More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students*.(41.6%) is least required as per Full-Time Students. Under *Others*, Students have asked for *Free academic software for installation on their own personal PCs / laptops* which they need for study purpose (Ref Table 4.28). **Full-Time Students want Antivirus to be installed on all PCs which means that students have found that antivirus are not installed on PCs available for their usage in the institute. They also want an increase in Internet bandwidth. They need trained I.C.T. Technical Support Staff which means that either institutes do not have adequate technical staff or they are not skilled enough to maintain the I.C.T. infrastructure. Most of the students feel that their inputs in I.C.T. security policy drafting will not much effect the satisfaction.**

- Full-Time Student responses have shown that they are *Satisfied* with *The overall I.C.T. Infrastructure Security* with Weighted Avg. 3.67 and nearly 78% showing positive responses for Satisfied (Ref Table 4.30). **Majority of Full-Time Students are in general Satisfied with overall I.C.T. infrastructure Security.**

- Majority Full-Time Student responses have shown that they Can't Say much about *The overall I.C.T. Digital assets security* with Weighted Avg. 2.94but ignoring Can't and Neutral responses13.30% have positive responses for Satisfied while 17.50% have shown negative responses w.r.t. overall I.C.T.

Digital Security(Ref Table 4.32). **Full-Time Students are Not Satisfied with overall I.C.T. Digital Security.**

- With respect to certain points which highlight the I.C.T. security scenario in Higher Technical Education Institutions, the Full-Time Student responses point out that 2 factors namely *I.C.T. security policy displayed in labs and prominent areas the institution, Have you ever been educated about your institution's I.C.T. Policy* where respondent's given more NO responses 57.01% and 62.30% respectively.

  Also, 79.3% respondents said they were able to install any software on their institution's PCs. Again, when it came to *Sharing I.C.T. username (e.g. internet, file drive) with friend*, 58.6% respondents said that they have done so. Similarly, 57.2% respondents have stated that their *data was destroyed by virus from the PCs or pen drives, etc. while they were accessing it on Institute's PC.*(Ref Table -3.37).**Full-Time Students have pointed have pointed out thatthat majority institutions either might not have a formally drafted I.C.T. security policy or they have failed to display it to general public users due to which students might not be aware ofthe existence of an I.C.T. security policy. This is a bad situation because if students have not been educated or enlightened about the various rules for I.C.T. usage covered under I.C.T. security policy, then how will they understand what they should do and what they shouldn't when using institution's I.C.T. infrastructure and services. Students have also revealed that they have shared their I.C.T. usernames with their friends and also that many times their data has been destroyed due to virus on institute's PCs.**

- With Respect to Areas to be addresses to improve I.C.T. security in the institutes, The foremost area suggested by Full-Time Students is *User Awareness about cyber laws* (87.6%). This is followed by *Train users to identify I.C.T. security risks* (86%). Stringent penalties (27%) is least favored area. (Ref Table 4.49). **Full-Time Students opinion w.r.t. Areas to be addresses to improve I.C.T. security in the institutes is more inclined towards educating the users about the cyber laws and creating awareness among the users regarding identification of potential areas which could create a breach in**

I.C.T. security. They do not favour any stringent on Users or technical Staff or any other staff on the institute to be used as a mean to forceful means to improve I.C.T. security.

5.1.4 PART IV: FINDINGS FROM HEAD OF INSTITUTE:

Head of Institution is one of the main administrative and decision making authority in institutions of Higher Technical Education. Thus, their opinion regarding various facets of I.C.T. infrastructure and services including policy decisions, budgetary decisions, etc.

For this type of respondent type of primary data was collected using questionnaires from 38 respondents who were either owners of institutions or were working as full-time paid Directors / Principals / HoD, etc. at Professional higher technical education institution running A.I.C.T.E. approved course and teaching only A.I.C.T.E. approved course.

In this case the data collection collected and analyzed based on following points (excluding certain general institute-related information) viz.Total Number of Staff members, Norms followed for creating your I.C.T. infrastructure, I.C.T. implementation support source, Total Number of PCs , Total number of Support Staff, Type of PCs and Servers, Internet Speed, Extent of satisfaction w.r.t overall I.C.T. infrastructure security, Extent of satisfaction w.r.t. overall I.C.T. Digital assets security, Level of I.C.T. attacks encountered, Role in I.C.T. Security Policy framing, Presence of I.C.T. up-gradation policy, Licensed Antivirus software available of PCs and Servers, Percentage of Annual Budget is set aside for I.C.T. and Actual expenditure Percentage made on New purchases / Up-gradation of I.C.T., Whether investment in I.C.T. infrastructure is every penny worth spent, Areas providing benefits and maximum Return of Investments on I.C.T..

- As per Head of Institute respondents (Ref Table- 4.2), *Vendor Support* (94.7%) has been most highly used sources for I.C.T. implementation in their educational institutions of higher professional education. This is followed by *Internal Sources* (60.2%). **Head of Institute respondents state that their institute have mostly used Vendor Support and Internal Source (staff) for setting-up and maintenance.**

- As per Head of Institute respondents (Ref Table- 4.5),A.I.C.T.E. Norms (100%) have been mostly followed by Affiliating University Norms(73.7%) and DTE Norms (65.8%) whereas UGC Norms (28.9%) has been least followed for creating I.C.T. infrastructure.**Head of Institute respondents state that in their institute A.I.C.T.E. Norms and Affiliating University are most followed for creating I.C.T. infrastructure but UGC Norms are least followed.A.I.C.T.E. norms being followed by majority of institutes is good but this needs to be verified.UGC norms is least followed but one reason for this is that UGC norms are not directly followed by individual institutions but by Universities.**

- 63.2% of Head of Institute respondents state that their institute uses only Branded Servers and PCs while 36.8% state that their institute uses both Branded and non-branded ones. 0% respondents stated that their institute uses Non-Branded Servers and PCs (Ref Table 4.10). **As per Head of Institute respondents, no institute uses Non-Branded PCs and Servers. Majority have stated to have been using Only Branded PCs and Servers. This ensures quality of installed I.C.T. infrastructure coupled with security of infrastructure and data.**

- Head of Institute's responses show that they are Strongly Satisfied (4.66) with overall I.C.T. infrastructure security with 100% positive responses for satisfaction (Ref Table- 4.30). **Head of Institute respondents are very Satisfied with I.C.T. infrastructure security.**

- Head of Institute's responses show that they are Strongly Satisfied with overall I.C.T. Digital assets security with majority of the respondents (94.8%) showing positive responses for satisfaction (Ref Table- 4.32). **Head of Institute respondents are very Satisfied with overall I.C.T. Digital assets security.**

- As per Head of Institute respondents (Ref Table 4.36), Low intensity attacks (1.92- Moderately low occurrence) is most frequently occurring followed by Mild (1.34-very low occurrence) and (1.05- very low occurrence). **This means that as per Head of institute respondents though Low, mild and high attacks**

are also occurring but their frequently occurring is very low. Of the three it is the Low intensity attacks which is most occurring.

- Head of Institute’s responses depict that their role is majorly as *Final Decision Maker* (76.3%) when it comes to role a respondent plays in creating I.C.T. policy. (Ref Table). **Majority of Head of Institute respondents are Final Decision Maker when it comes to I.C.T. policy making.**

- 39.5% of the Head of Institute state that *Formal I.C.T. Up-gradation policy* is not present while 36.8% say it is present in their institution (Ref Table 4.45). **As per Head of Institutes majority of institutions do not have a formal drafted I.C.T. Up-gradation policy. This means that there is no planned upgradation in I.C.T. infrastructure. Upgradation decision will thus depend on priority and need along with the perception of the need in the eyes of the head of Institution who is final decision maker in financial matters.**

- 65.8% Head of Institute state that *All Servers* have antivirus installed on them while 34.2% state that *Few Servers* have antivirus installed on them. This means that majority of servers are protected by antivirus. On the other hand, 44.7% Head of Institute respondents state that *All PCs* have antivirus installed on them whereas 55.3% state that *Few PCs* have antivirus installed on them(Ref Table 4.32).**As per Head of institute respondents, majority institutes have antivirus installed on all servers but when it comes to PCs majority of institutions do not have antivirus installed on all PCs but instead on few machines. Thus, in considerable number of cases, considerable number ofPCs not are protected by antivirus.**

- When it comes to Percentage of Annual Budget set aside for I.C.T., The highest responses from Head of Institute (36.8%) is for *15% to 20%of annual budget set aside for I.C.T.* followed by 26.3% for *20% and Above. (*Ref Table 4.52*).* But on an average only 17.98% of Annual Budget is set aside for I.C.T. (Ref- Table 4.53) as per Head of Institute respondents.**As per Head of Institute responses, majority institutes dedicate only 15% to 20% of their Annual Budget for I.C.T. and the avg. percentage of I.C.T. budget is 17.98%.**

- As per Head of Institute, highest responses have been received by *60% to 80% of sanctioned I.C.T. budget* (36.8%). Only 21.1% respondents say that 80% and above of sanctioned I.C.T. budget is being actually used by the institutes. (Ref Table- 4.54). **As per Head of Institute respondent responses only 21.1% institutions are using 80% or more of the budget allocated for I.C.T..**

- Ref Table 4.56, Head of Institute (100%).have Strongly Agree upon the statement "Investment in I.C.T. infrastructure is every penny worth spent". **All Head of Institute Strongly Agree upon the statement "Investment in I.C.T. infrastructure is every penny worth spent".**

- As per Head of Institute Respondent's views (Refer Table 4.60), *Communication* has Ranked at No. 1 (100% High Return responses) followed by *Research* (Rank 2; 100% High Return responses), and *Stationary (e.g. paperless office)* (Rank 3; 100% High Return responses) and show weighted averages that correspond to *Very High* Return. In fact, all areas under study have shown trends of *Very High* Returns as per Head of Institute Respondents expect for *Automation and integration Manpower (Teaching, Non-teaching, etc.) staff* and *Others* which have showed trends of *High* returns. **As per Head of Institute respondents all areas under study have shown good amount of benefits / Return on Investments. Of these *Communication* and *Research* (both 100% high return responses)are the areas which gives maximum benefits. Manpower (Teaching, Non-teaching, etc.) staff comes last in the list.**

- As per Head of Institute Respondent's views (Refer Table 4.65), *Knowledge Sharing*, *Effective communication between staff, students and other stakeholders*, *Reduction in teaching-learning costs*, *Increase in admissions* have same Weighted Averages and actually share the Rank No. 1 *(*Avg. weight- 4.97; 100% Agree responses) and shows weighted averages corresponding to *Strongly Agree.Attract more students and expert faculty members, Staff Skill development,* and *Reduced administrative costs* rank at No. 2 *(*Avg. weight- 4.97). *Facility rentals for corporate training and online exams (*Avg. weight- 3.79)ranks last but has weighted average corresponding to Agree.**As per Head of Institute respondents all listed items have given High benefits. Of these *Knowledge Sharing, Effective communication between staff, students and other***

stakeholders, Reduction in teaching-learning costs, Increase in admissions **have shown highest benefits. Though *Facility rentals for corporate training and online exams has also shown to be beneficial* but it has been placed at the bottom of the list.**

5.1.5 PART V: OVERALL FINDINGS:

A total number of 38 Head of Institute (Management) respondents, 332 Full-time teaching staff respondents, 435 Full-time students (Learners) respondents and 111 Technical Support Staff respondents were used to collect Primary data for the purpose of obtaining the objectives of the study. In this section we look at the overall response trends of the various respondents taken together for obtaining an overall view regarding the various factors under study for each objective type.

- Overall, majority of institutions having *Upto 300 students* have the minimum required number of PCs. In fact, 36.7% institutions having upto 300 students have even more than 150 PCs. 66.7% institutions falling in the range of 300 to 600 students have only minimum 150 PCs. While only 33.3% institutions have the required or amount of PCs. 36.8% institutions falling in the range of *300 to 600 students* have less than minimum of 300 PCs. 52.6% institutions have the required amount of minimum 300 PCs while 10.5% institutions have more than the required amount of PCs. (Ref Table 4.2) .**Overall, majority of the institutes with less (upto 150 students) have been found to have minimum or higher number of PCs than required. The trends indicate that as the institutions grow and increase their intake, of students they fail to increase the number of PCs required as per norms. But once their intake crosses 600 students the situation improves.**

- Overall, *Vendor Support* (87.92%) has been most commonly used for I.C.T. implementation in the educational institutions of higher professional education. Second choice has been the *Internal Sources* (46.98%). The least chosen one is *Large general consulting firm* (22.82%). (Ref Table 4.4). **Overall most preferred or used source of I.C.T. implementation is Vendor Support followed by Internal Sources. Large general consulting firm and Independent specialist consultants are least preferred which makes us conclude that there is a wide difference in attitude of higher education**

institutes and Industry when it comes to I.C.T. infrastructure implementation.

- Overall it is the *A.I.C.T.E. Norms* (74.49%) which have been most commonly been followed to create I.C.T. infrastructure. This is followed by *Affiliating University Norms* (49.44%).(Ref Table 4.6). **Overall most commonly followed norms for creating I.C.T. infrastructure is A.I.C.T.E. norms followed by Affiliating University norms.**

- Overall, *Branded PCs and Servers* (67%) are most commonly available in higher technical education institutes while those usinga mix of Both Branded and Non-Branded PCs and Servers (32%) come on the second place.(Ref Table 4.11) **Overall majority of institutes use Branded PCs and Servers.**

- ***In-House developed software* are not frequently used.**

- For 300 to 600 students, minimum internet bandwidth requirement is 5 Mpbs. 33.33% have bandwidth between 5 to 10 Mbps while 58.3% have 10 Mbps and above. For the student range of 1200 to 1500 students, the minimum required bandwidth is 10 mbps. Only 28.6% institutions in this range has subscribed this bandwidth while 71.4% institutions have subscribed internet bandwidth below this minimum level. (Ref Table 14.13a). **Overall, when institution's intake is less the required internet bandwidth subscription is available and in some cases even more but the institutions which have enrolled students in the range of 1200 to 1500 must have atleast 10 Mbps internet speed but only 28.6% institutes have it.**

- Overall, Broadband (51.4%) tops the list as most commonly used Internet connection type followed by Leased-line (48.6%). Other traditional types of connections like ISDN and Dial-Up are not at all being used.(Ref Table 4.17). **Overall, most commonly used connection type by higher technical education institutes is Broadband followed Leasedline. ISDN and Dial-up connections are no longer preferred.**

- As per Technical and Teaching Staff combined responses *Research Work* (4.46) is the most common purpose for the usage of I.C.T. infrastructure in Higher technical Education Institutions and is Ranked **FIRST** and show tendency of *Very Frequently used.Email* (4.38) is ranked **Second** whereas *Lecture Preparation* (4.10) has been ranked **Third**. Both show tendency of *Frequently* used. *Job Searching*(2.25) and *Listening to Songs and Videos*(2.18) is the least preferred purposed as per combined view of technical and teaching Staff. . For Students the main purpose for use is Email, lecture and practical sessions, &Social Networking. Least used purposes are View Online Lectures and Vocational Training. (Ref Table 4.21and Table 4.22). **As per Technical and teaching staff, Research Work, Email and Lecture are most common purposes for which I.C.T. infrastructure of educational institute is used. Contrary to this, Job Searching and Listening to songs and videos is least used. While Teaching Staff's usage pattern depicts their inclination towards usage of I.C.T. infrastructure for academic purpose, the Student's usage pattern depicts that students are more inclined towards entertainment and socializing and that academics is their second preference w.r.t. using their institute's I.C.T. infrastructure.**

- (Ref Table 4.22)Overall, majority of institutions are Not Connected with ERNET (48.6%). **One reason for this is that ERNET is not available to private educational institutions. That is also the reason why a lot of Technical Staff respondents are not aware of its existence.**

- Overall(Refer Table 4.23), 86.49% respondents say that their institution has Wi-Fi network installed while only 13.51% respondents say that their institution doesn't have Wi-Fi network installed.**Overall, majority of the institutions have Wi-Fi network installed in their building / campus. This is good indication but it is not clear whether Wi-Fi internet availability is allowed for students or it is just limited to usage by Staff and Management.**

- Overall, *Communication facilities (email, SMS, alert messaging, etc.)* is Ranked **First** (4.27) w.r.t. Satisfaction trends among users. This is followed by *Internet services through wired network* (3.91) and *Academic application software* (3.65) at Second and Third Ranks respectively. All three of them show trends of Satisfied. *Storage and Backup utilities* (2.86) ranks at Eighth position and end at the bottom of the list. (Ref Table 4.27). **Overall, as per respondents the top-**

most I.C.T. services with which respondents are satisfied are Communication facilities, and internet through wired network. Academic software are also available in institutions. But Internet through Wi-Fi is not in top 3 list.Also data Backup and Storage facility is right at the bottom of the list. This indicates that (i) Wi-Fi internet might be present in the institution but access might be available to only select few classes of users. (ii) Institutions are lacking in having properly managed Data storage and Backup facilities. Academic and financial records are at the heart of an academic institution. As we are moving towards digitization and moving away from Paper-based record keeping, lack of data backup facilities can be catastrophic.

- Overall, the most highly desired measure to improve user satisfaction as per all types of respondents is *Antivirus*(91.80%),*Training of technical support staff*(79.04%) and *Increase Internet bandwidth and making available on all PCs*(79.04%). *More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students* (55.47%) is the least required improvement area desired by respondents collectively. (Ref Table 4.29). **Overall most desired measures to improve user satisfaction is installation of Antivirus on PCs and Servers followed by *Training of technical support staff* and *Increase Internet bandwidth and making available on all PCs*. *More Frequent updating of organization's. More Frequent updating of organization's I.C.T. Security Policy in consultation with stakeholders including staff and students* is least preferred.**

- Overall, the respondents are Satisfied (Combined Weighted Avg. 3.87) with the I.C.T. infrastructure security being maintained in Higher Technical Education in Pune region. (Ref Table 4.31). **Overall all respondents have shown that they are satisfied with overall I.C.T. infrastructure Security. But we must remember that I.C.T. security must be maintained at its peak i.e. responses should show Very Satisfied levels but this not so. Even slight lapse in security can compromise security of valuable data. Therefore, researcher infers that more need to be done to reach the Very Satisfied level.**

- Overall responses of all respondents taken together reveals that the users have not given a very clear picture regarding whether they Satisfied or not with overall I.C.T. Digital assets security. The value of Combined Weighted Average (3.41) is more inclined towards Neutral. Further analysis has revealed that Technical Staff and Head of Institute are satisfied with Overall I.C.T. Digital assets security but it is possible that their response could be biased as both are directly linked to I.C.T. security aspect as owners / service providers. On the other hand, Students who are the end-users are actually dissatisfied. We must take in mind that the Students are in majority in the category of end-users and their dissatisfaction must be taken into consideration. (Ref Table 4.33). **Overall, the combined Weighted Avg. shows results which are closer to Neutral trends w.r.t.overall I.C.T. Digital assets security. But deeper analysis shows even though individually Technical Staff and Head of Institution show trends of Satisfaction but Students have shown trends of Dissatisfaction.**

- Overall The Combined Weighted Average for Low Intensity (2.35) infers that Low intensity attacks have Moderately Low rate of occurrence on overall basis (Ref Table 4.37). The Combined Weighted Average for Mild Intensity (1.67) infers that Mild intensity attacks have Moderately Low rate of occurrence on overall basis. (Ref Table 4.38). The Combined Weighted Average for High Intensity (1.46) infers that High intensity attacks have Moderately Low rate of occurrence on overall basis (Ref Table 4.39).**Overall, Low Intensity attacks have more frequency of occurrence than Mild and High ones. It has been found that lots of I.C.T. attacks that happen in higher educational institutions have students involved in it who either try to create attacks for fun or as a challenge, etc. This is a common trend in countries like USA but India is still lagging behind. We must understand that Indian students are still raw and lack technical skills but in future as the generations of students change and their technical skills are enhanced, these figures which are, as of now, for Low Intensity attacks might change into those for High Intensity attacks.There is one more important fact that needs to be considered. Still there are lots of academic institutions in India who have not brought all their servers and data fully online that's why hackers and attackers might**

have not have been attracted to attack them. But as they will be digitized High Intensity attacks may well occur there also.

- Head of Institute's responses depict that their role is majorly as *Final Decision Maker* (76.3%) while Technical Staff's responses depict that majority of these respondent's role in Policy Making is confined to *Consultative* (82.9%). (Ref Table 4.40). **Overall w.r.t. Role in I.C.T. policy making, I.C.T. Technical Staff is more into giving Consultancy while Head of Institutes are the Final decision makers**

- Overall w.r.t. Presence of formal I.C.T. Up-gradation Policy in the higher technical education institution, only 23.28% respondents have given a YES response where as 37.21% have given NO response. 39.50% have given Can't say responses and have, therefore, been omitted (Ref Table 4.42).**Overall, only 23.28% respondents have stated that their institution has aFormal I.C.T. Up-gradation Policy while majority have stated that it is not present.**

- Overall in case of Servers, 56.38% respondents say it is installed on all Servers whereas 40.94% say it is installed on few servers in their technical higher educational institution. Overall, in case of PCs, 34.23% respondents have opined that antivirus is installed on *All PCs*, but on the other hand 65.77% say that it is installed on *Few PCs*. (Ref Table 4.44). **Overall, Majority of respondents have reported to have antivirus installed on all Servers. But in case of PCs in most cases on an average the antivirus is not installed on all PCs in the institution. Further, in both cases, it is seen that Antivirus is installed on Few Servers and Few PCs (majority in case of PCs). But we are not clear about the exact percentage of machines when we are dealing with the term "FEW". Thus, if in case, the percentage of antivirus installed machines (Servers and PCs) is in minority then this is not a good trend as servers are the machines where majority data is stored or they provide vital network services and if they are not secured then it is a problem worth noting. One of the biggest threats to data in academic institutions comes from students who work on public PCs available in computer labs of their academic institutions. Lack of antivirus on such public computers is very bad for the security of data in such institutions.**

- Overall, *Lack of Technical staff, Carelessness of users, Lack of equipment / technology / software in the institution to avoid I.C.T. attacks* Ranked I, II and III and showed weighted average corresponding to High Role as Factors which play major role in committing of I.C.T. security attacks. *Lack of hardware / data ,etc. disposal policy, Lack of Content management, Lack of Data Governance (Management/storage/dispersion) policy,* and *Lack of fixation of responsibility and liabilities on users* which are ranked at 14th, 15th, 16th and 17th rank show weighted averages which correspond to neutral responses from respondents. Another factor of interest is *Pirated software* where 90.09% respondents have stated that it plays High Role in committing of I.C.T. Security attacks.There are some other factors also which have been stated by Respondents in *Others* category which are of interest. Some of these factors include Allowing students to access internet on Mobile smart phones, *Allowing students to use Pen drives on PCs*, *Exchanging user passwords by users with other users*, *Careless of users while browsing internet which causes installing of Spyware and Adware*, *No antivirus on machines*, *Antivirus not updating its virus database*, etc. Researcher also came across a peculiar case where respondents said that their *Lab PCs had antivirus but there was no regular internet in labs to update them*. (Ref Table 4.45). **Overall, factors which play highest role in committing I.C.T. security attacks are*Lack of Technical staff, Carelessness of users, Lack of equipment / technology / software in the institution to avoid I.C.T. attacks. Lack of Data Governance (Management/storage/dispersion) policy,* and *Lack of fixation of responsibility and liabilities on users* are last in the list. Other reasons sited are Allowing students to access internet on Mobile smart phones, *Allowing students to use Pen drives on PCs, Exchanging user passwords by users with other users, Careless of users while browsing internet which causes installing of Spyware and Adware, No antivirus on machines, Antivirus not updating its virus database*, etc.**

- Overall the top most factors which might be playing high role in reducing/preventing I.C.T. security attacks are *Technical staff able to manage I.C.T. infrastructure and its security*(3.53) ranks **First** and falls under *High Role,* followed by *Antivirus, firewall, auto-updates, etc.*(3.43) ranks **Second**, and *Educating of staff and students about I.C.T. laws and Best Practices*(3.39) ranks

Third. All these fall under *Average* role.(Ref Table 4.48). **Overall *Technical staff able to manage I.C.T. infrastructure and its security* and *Antivirus, firewall, auto-updates, etc.* are the factors that respondents feel have played most important role in curbing I.C.T. security attacks in institutions of Higher Technical education.**

- Overall, *User Awareness about cyber laws* (85.65%), *Train users to identify I.C.T. security risks* (84.05%), and *Identification and blocking loopholes in security* (80.52%) are the top-most Areas need to be addressed to improve I.C.T. security in the institutes. Whereas Stringent penalties are least related as per combined responses of all respondents.(Ref Table 4.50). **Overall User Awareness about cyber laws, Train users to identify I.C.T. security risks and Identification and blocking loopholes in security most top rated Areas need to be addresses to improve I.C.T. security in the institutes. Respondents are not in favour of using Stringent Penalties as a way to improve I.C.T. security.**

- Overall, *I.C.T. security policy displayed in labs and prominent areas the institution,* and,*Have you ever been educated about your institution's I.C.T. Policy* where respondents have given more NO responses 57.01% and 62.30% respectively. This means that institutions might not have a formally drafted I.C.T. security policy or they have failed to display it to general public users. (Ref Table 4.51). **Overall, it has been found that *I.C.T. security policy displayed in labs and prominent areas the institution*is not displayed, *and users have not been educated about your institution's I.C.T. Policy.* These are two very big loopholes in the I.C.T. security in higher Technical education institutions.**

- Overall, most institutions are allottingat an average of only 18.13% of their total annual budget for I.C.T.. (Ref Table 4.53).**Overall, Very small percentage of Total Annual Budget of the Higher Technical Education Institution is being allocated for I.C.T..**

- Overall, it can be inferred that most institutions are actually spending only 53.14% of their total Annual Budget set aside for New Purchases / Up-gradation of I.C.T.. (Ref Table 4.55). **Overall, approximately 50% of the total Annual Budget set aside for New Purchases / Up-gradation of I.C.T. by Higher Technical Education Institution is being allocated for I.C.T. is actually used.**

- The combined weighted average of 4.57 indicates that on overall respondents *Strongly Agree* to the statement that "Investment in I.C.T. infrastructure is every penny worth spent" (Ref Table 4.57). **Overall the statement "Investment in I.C.T. infrastructure is every penny worth spent" has been strongly agree to by all respondents taken together.**

- Overall, Communication (4.56) and Research (4.54) are ranked First and Second respectively and respondents have Strongly Agreed upon this that these are have shown highest extent of benefits or Return of Investments on I.C.T. received from various areas as per responses of Head of Institute. It is interesting to see that *Information storage and access* (4.22), *Examination process* (4.10), *Stationary e.g. paperless office* (3.93) have landed at 4th, 6th and 9th Rank in the list. Though these have shown trends of Agree, still they have landed quite low in the list.(Ref Table 4.62). **Overall, Communication and Research have given highest return or benefits from investment in I.C.T. by higher technical education institutions. There is still much return from areas like Information storage and access, Examination process, Stationary e.g. paperless office.**

- **Overall there is very high diversity between the opinions of various respondent types w.r.t. benefits provided by I.C.T. implementation in higher technical education institutions. (**Ref Table 4.66**). But as per combined weighted averages of all the respondents, we find that** *Knowledge Sharing* (4.63[Strongly Agreed]) is the benefit which has been Ranked First. *Effective communication between staff, students and other stakeholders* (4.36), *Maximize resource utilization including learning resources*(4.35), and *Standardize processes*(4.35) come at Ranks Second, Third, and Four respectively. Facility rentals for corporate training and online exams, Reduced need of direct attention, Reduced labour costs have not been able to be very beneficial and have landed at the bottom of the list. (Ref Table 4.67).**Overall *Effective communication between staff, students and other stakeholders*,**

***Maximize resource utilization including learning resources*, and *Standardize processes* have proved to be most beneficial. But the benefits from Facility rentals for corporate training and online exams, Reduced need of direct attention, Reduced labour costs are not that much lucrative.**

5.2 CONCLUSIONS:

After going through the data and analyzing and interpreting it, the researcher has come up with the following conclusions:

- **PC-Student ratio:**The Management colleges which have higher number of enrolled students i.e. more than 900 but less than 1200, in majority of cases have lesser number of PCs than required.
- **I.C.T. Implementation and maintenance Sources:** Most institutions rely on Vendors and Internal Staff for setting-up and maintaining I.C.T. infrastructure and its security. Unlike their industry counter-parts, they, in majority of cases, don't use external Experts and Consultants. Looking at the current delicate situation in I.C.T. security along with continuing digitization of academic sector, this is a very volatile situation.
- **Norms followed for creating I.C.T. infrastructure:** Majority of the Institutions are following A.I.C.T.E. norms, the foremost agency to regulate higher technical education in India. But this is "majority" and not 100%. This means some institutions are somehow by-passing A.I.C.T.E. Norms. This is evident from section4.2.1 where management institutes with higher number of enrolled students were not having adequate number of PCs. Moreover, too many norms from too many regulatory and accreditation bodies creates problems for institutions from administrative and compliance point of view.
- **Availability of basic I.C.T. equipment to users:** PCs are available to users as per Technical staff, Teaching staff.. But when it comes to Printers, they are available to Staff members only. All users agree that Laptops and Scanners are not available. This means that printers are not being made available to student users whereas either institutes don't have scanners and

printers or they provide it only to a select few. Therefore, we conclude that basic I.C.T. equipment and tools are only available in part to the users.

- **Types of PCs and Servers available in institutions:** Majority of the respondents i.e. Technical Staff, Full-Time Teaching Staff, and Head of Institute state that Only *Branded PCs and Servers* are being used in their institution. Overall, also the majority is with *Branded PCs and Servers*. In contrast, Responses from all the 3 types of respondents clearly shows that there are very few institutions that are using *Non-Branded PCs and Servers* alone (less than 5%). This is a good indication because Branded PCs and Servers are obviously good in quality, trust worthy, last long and their performance is also much better than Non-Branded ones. The data is also safe. One drawback of this data is that that we can't exactly say the ratio of Branded and un-branded PCs and Servers in cases where institution is using both Branded and Non-Branded PCs and Servers. Considerable number of institutions (25% to 50%) use such a combination. If ratio of Non-Branded is higher, then it is a matter of concern as non-branded ones are frequently of inferior quality with high failure rate.
- **Type of Software Used:** Technical and Teaching staff responses indicate that Licensed Software are the most commonly used software. Open-Source software are also quite commonly used. Problem persists with Trial-Version software are also used in abundance, and In-house Developed software which are not very prevalently used. On one hand, Trail-Version software depict a great vulnerability w.r.t. I.C.T. attacks through virus, spyware, Trojans, etc., while on the other, less use of In-house developed software depicts institutions, especially those institutions which are running Technical courses in the field of computers, are not utilizing the skills of their staff and students to practically develop software which could give a good practical exposure to them.
- **Internet Speed:** All institutions have internet which is as per the norms setup by A.I.C.T.E..

- **Internet Connection Type:** All institutes have internet connection. Of these Broadband and Leasedline are most common in use w.r.t. higher technical education institutes.
- **Purpose for using I.C.T. infrastructure:** It is evident that there is a sharp difference between the usage patterns of Students and teaching staff. While Teaching Staff's usage pattern depicts their inclination towards usage of I.C.T. infrastructure for academic purpose, the Student's usage pattern depicts that students are more inclined towards entertainment and socializing and that academics is their second preference w.r.t. using their institute's I.C.T. infrastructure. Staff working in Teaching or technical areas do not like to waste their time in leisure work during working hours and prefer spending more time in Research work and institutional activities.
- **Connection to ERNET**: Majority of institutions are not connected with ERNET. One reason for this is that ERNET is not available to private educational institutions. That is also the reason why a lot of Technical Staff respondents are not aware of its existence.
- **Wi-Fi Network in institute:** Wi-Fi network is generally available in majority of Professional Higher Technical Education institutions.
- **Satisfaction among users w.r.t. select I.C.T. services provided by Institution:** With respect to select I.C.T. services provided by Institution, on the brighter side, Communication, Internet through wired Network, maintenance and Support, and Academic Software are frequently seen in the first 3 positions even though there is difference in perception of the 3 respondent types. Overall also the scenario is the same. This makes us conclude that respondents are very much satisfied with these services.

  Again on the darker side, Storage and Backup utilities constantly appears at the bottom of the list and respondents have shown very low satisfaction in this case. This means that this facility is either not available at all or is not available to all users. Researcher must point out that, Academic and financial records are at the heart of an academic institution. As we are moving towards digitization and moving away from Paper-based record keeping, lack of data backup facilities can be catastrophic.

Internet through Wi-Fi is yet another facility which failed to appear in top 3 facilities which means that Wi-Fi (ref point 11) even though it is available in majority of institutions but then it is either available for use of select few or there are connectivity/ low bandwidth issues.

- **Measures to improve User Satisfaction:** There is definitely a difference in opinions of different respondent types regarding what should be done to improve user satisfaction. However, *Antivirus* has been a common factor that has come in majority of case at the top. Apart from this, *Increase in number of technical support staff* is another factor which features at the top. Few of the suggestions for improvement as prescribed by the respondents include *24*7 printing facility, printing facility in hostels, on-line academic document ordering and verification system, centralized I.C.T. technical desk helpline, college providing copy of academic software to use at home*, etc.

- **User Satisfaction w.r.t. overall I.C.T. infrastructure security:** Majority of respondents are found to be satisfied with overall I.C.T. infrastructure security. Overall, also the respondents are satisfied.

- **User Satisfaction w.r.t. overall I.C.T. Digital assets security:** Majority of the teaching staff and Head of Institute are Satisfied with overall I.C.T. digital asset security. On the other hand, Students who are the end-users are actually dissatisfied. We must take in mind that the Students are in majority in the category of end-users and their dissatisfaction must be taken into consideration.

Overall responses of all respondents taken together reveals that the users have not given a very clear picture regarding whether they Satisfied or not. Firstly, it is possible that responses of Head of Institute or Teaching Staff could be biased as both are directly linked to I.C.T. security aspect as owners / service providers. Secondly, it could be possible that laboratory machines are not well maintained or are virus hit due to unavailability of antivirus on lab PCs which lead to destruction of student's data. Section 4.4.6 does indicate that in majority of institutions the antivirus is not installed on *all PCs.*

- **Severity and Frequency of I.C.T. security attacks:** Overall, Low Intensity attacks have more frequency of occurrence than Mild and High ones. It has been found that lots of I.C.T. attacks that happen in higher educational institutions have students involved in it who either try to create attacks for fun or as a challenge, etc. This is a common trend in countries like USA but India is still lagging behind. We must understand that Indian students are still raw and lack technical skills but in future as the generations of students change and their technical skills are enhanced, these figures which are, as of now, for Low Intensity attacks might change into those for High Intensity attacks.There is one more important fact that needs to be considered. Still there are lots of academic institutions in India who have not brought all their servers and data fully online that's why hackers and attackers might have not have been attracted to attack them. But as they will be digitized High Intensity attacks may well occur there also.

- **Respondent's Role in Policy Making:** Technical Staff, even though they are at the operational level in I.C.T. infrastructure and maintenance, are not the Final Decision Makers w.r.t. I.C.T. policy making. In majority of the cases, the Final decision vests with the Head of Institute on the institution who may or may not take advice of Technical Staff. If they don't take advice then it can be treated as I.C.T. security gap as Head of Institute are not technical experts in the area of I.C.T. security. Thus, a potential problem area.

- **Presence of formal I.C.T. Up-gradation policy in the institution:** Overall,only 23.28% respondents state that formal I.C.T. Up-gradation policy in the institution. This is an alarming state with regards to I.C.T. security scenario. This is because as new technology is coming up, new ways to create I.C.T. security attacks are coming up. If the institutions don't have formal up-gradation policy it means that they are not upgrading themselves win orderly manner and might fail to have enough technical capability and infrastructure to combat future possible I.C.T. security attacks. We can, thus, infer that due to lack of I.C.T. Up-gradation policy, the academic institution data in under high security threat on one hand, whereas on the other hand, Institutions are not providing quality I.C.T. infrastructure to their students who pay high amount of fee.

- **Antivirus installed on Servers and PCs:** 40.94% (*Antivirus Installed on few Servers*) and 65.77*(Antivirus Installed on Few PCs)* is not a good trend. Servers are the machines where majority data is stored or they provide vital network services and if they are not secured then it is a problem worth noting. Same way PCs without antivirus are potential points from where virus can enter the network.Basically, what is expected is that each and every PC and Server should have an antivirus.

- **Factors which play major role in committing of I.C.T. security attacks:** *Lack of technical staff* and *carelessness of users* has been found to be the top most factor for committing I.C.T. security attacks. Use of Pirated Software is another factor to look for. *Lack of hardware / data, etc. disposal policy*, *Lack of Content management*, *Lack of Data Governance (Management/storage/dispersion) policy*, and *Lack of fixation of responsibility and liabilities on users* have lesser role as per respondents. Other factors include *Allowing students to access internet on Mobile smart phones*, *Allowing students to use Pen drives on PCs*, *Exchanging user passwords by users with other users*, *Careless of users while browsing internet which causes installing of Spyware and Adware*, *No antivirus on machines*, *Antivirus not updating its virus database*, etc. and Antivirus on *Lab PCs not regularly updated.*

  It needs to be noted that each factor doesn't by itself causes attacks or increases the risk of attacksbut when one or more of them come together I.C.T. attacks become imminent.

- **Success extent of factors in being able to reduce / prevent I.C.T. security lapse or attack:** It is the *Technical staff able to manage I.C.T. infrastructure and its security* and *Antivirus, firewall, auto-updates, etc.*

which have been found to be most influencing factors in reducing / preventing I.C.T. Security attacks. *Security audit able to find gaps in I.C.T. security* has been found not to be very useful.

Researcher has also found that not too many institutions are conducting I.C.T. security Audits which is contrary to the practices followed in industry.This is evident from the fact that*Security audit able to find gaps in I.C.T. security* (2.48) has found to be least preferred.

Thus, it can be inferred that *Technical staff able to manage I.C.T. infrastructure and its security* and *Antivirus, firewall, auto-updates, etc.* are the factors that respondents feel have played most important role in curbing I.C.T. security attacks in institutions of Higher Technical education. Also in Indian context, Security audit has proved to be of no use as it is not conducted on regular basis.

- **Areas that need to be addressed to improve I.C.T. security in the institutes:** User Awareness about cyber laws is overall best solution for improvement in I.C.T. security. Stringent Penalties, which has highly demanded by Technical staff is not found to be acceptable by all other respondents.

- **Current I.C.T. scenario from Student User's prospective**

  They data has been analyzed in Two parts:

  <u>Discrepancies found:</u>

  a. Only 43% students stated that Is I.C.T. security policy displayed in labs and prominent areas in the institution.

  b. Only 37.7% students stated that been educated about your institution's I.C.T. POLICY.

  c. 79.3% students stated that they you able to install any software on your institute's PCs

d. 57.2% students stated that their data was destroyed by virus from the PCs or pen drives, etc. while they were accessing it on your Institute's PC.

e. 58.6% students stated that they shared their I.C.T. username (e.g. internet, file drive) with their friends.

<u>Positive aspect:</u>

a. 69.7% students said that they have been educated about Cyber laws (e.g. IT Act 2000, etc.) by your institution

b. 71.3% students stated that there is restriction on what is surf on the college internet

c. 5.3% students stated that institution's Website was hacked.

This makes us conclude that, On the negative side, majority of students stated that I.C.T. security policy was not displayed in prominent areas of their institute. Majority of them also stated that they were not educated about the institution's I.C.T. policy. Majority Students were able to install any software by themselves. They even shared their secret usernames and passwords with their friends. These result are in line with another fact found that majority of students faced destruction of their data while working on it on institution's I.C.T. network. Absence of I.C.T. security policy or user's not knowing about its contents, might be because it is not displayed, is one of the biggest reasons why users indulge in activities (knowingly or unknowingly) which can lead to compromise in I.C.T. security.

A positive thing that has been observed majority institution's website has not been hacked and that majority of the students have been *educated their about Cyber laws (e.g. IT Act 2000, etc.) by your institution* where 69.7% .

- **Percentage of Annual Budget set aside for I.C.T.:** Costs related to I.C.T. include Recurring costs like internet bills, repair and maintenance, subscriptions for anti-virus, salaries for technical staff, upgrading of hardware and software, and Non-recurring costs like buying new hardware and software, creating computer labs and laying the network and electrical cables, etc. Both non-recurring and recurring costs are quite high. Increasing dependency on I.C.T. has increased costs related to I.C.T.. An average of 18.13% of Annual budget looks quite small in such a scenario.

- **Percentage of Annual Budget set aside for New purchases / Up-gradation of I.C.T. is actually used:** Overall, approximately 50% of the total Annual Budget set aside for New Purchases / Up-gradation of I.C.T. by Higher Technical Education Institution is being allocated for I.C.T. is actually used.

  This is an alarming condition as this means that *Non-recurring and Recurring expenditures* on I.C.T. are not met which may lead to problems in buying anti-virus, firewalls, repairing / replacing old machines, etc. culminating in higher rate of network and machine failures, loss of data, etc.

- **Investment in I.C.T. infrastructure is every penny worth spent:** People have understood the importance of I.C.T. in education especially Professional Higher technical Education and have Strongly agreed that there are lots of benefits in investing in I.C.T. infrastructure in their educational institutions.

- **Extent of benefits or maximum Return on Investments on I.C.T.:** There is difference in perception of respondents w.r.t. areas which have given high return on investment in I.C.T.. However, Communication and Research have emerged as the winners. Presence of *Information storage and access* (4.22), *Examination process* (4.10), *Stationary e.g. paperless office* (3.93) low in the list makes us infer that digitization is still not fully done and that these have still not been able to reduce the monetaryexpenses involved in storage of data and saving huge amount of stationary spent in examination process.

- **Benefits provided by implementation of I.C.T. in higher technical education institution:** There is difference in perception of different types of respondents w.r.t. benefits provided by I.C.T.. However,*Knowledge Sharing, Effective communication between staff, students and other stakeholders, Maximize resource utilization including learning resources, Standardize processes, Increase in admissions have come in Top 5.* But these might have got majority positive responses but the results should be 100% effective.

SUMMARY OF CONCLUSIONS

To conclude, the researcher has found lots of positive points as well as negative points when talking about ICT facilities in Higher Technical Education institutes. There is a deficiency of PCs in certain types of institutes. This is also accompanied by the problem of having a number of different versions of norms being forced upon the Management of educational institutions by different accreditation and regulatory authorities. Continuous digitization of academic sector is taking place and not taking expert help in setting up ICT infrastructure is a cause of concern. Management is not allowing students to use printers, laptops and scanners even after paying a huge fee. Similar is the case with the Wi-Fi facility where Management is not allowing students to use the facility. These being the part of basic ICT facility is causing a lot of dis-satisfaction among students. The Management of institutes at many instances has also failed to provide anti-virus on PC. The Management of institutes has also don't have an ICT security policy, ICT audit policy, ICT Up-gradation policy and to make things worse, the budget for ICT is low and actual spending is even lower. There is also manpower shortage.

Still Management of institutes can't be fully blamed. The government has also failed to mention certain specifications w.r.t. ICT facilities through its ICT regulatory authorities.

Benefits realized from ICT have also not gone well. Management of institutes as well as education regulators and universities should change their way of thinking and adopt online examination system and paperless culture (digitization of documents and office work). These two areas take up lot of time and money and must be worked upon.

If right policies and directives are in place, the Management of institutes will also be bound to implement these in their own policies and decisions and then only there will be satisfaction among the various users of ICT in institutions.

Looking at the summary, we can, thus, conclude that appropriate number of factors have been studied for this particular objective and so the study of this objective has been successfully completed

5.3 SUGGESTIONS:

Looking at the conclusions of the study, the researcher wishes to present a number of suggestions which if practiced would definitely improve the situation.

The researcher hereby presents these suggestions inthree parts:

i) There are Areas which are not at all doing well and are under performing.

ii) There are Areas which are doing well but then there is always a space for furtherimprovement

iii) The Framework

I) Areas which are not at all doing well and are under performing.

- There have been a deficiency of computers in Management strata where substantial number of institutes showing such a pattern. Such institutions must buy more PCs or they might rent them.

- Study has shown that certain institutions, though they say they are following all norms as devised by A.I.C.T.E., DTE, etc. but certain institutions somehow do manage to escape. These bodies can appoint a 3rd party to annually audit I.C.T. infrastructure in academic institutions. This trend is quite prevalent in industrial in areas such as quality control, compliance, etc.

- Too many norms from different regulatory and accreditation bodies causes chaos. Administrative and compliances issues make it difficult for the institution'sManagement to comply with so many norms. One single body, preferably the UGC should make ICT related norms for all types of higher education institutions for pan-India. Later, AICTE, University, NBA, NAAC, etc. should all follow these norms only. Based on type of institution, like university or college, etc. the norms can be formed but by same apex body.

- Not all institutions specially those which are located in rural areas and/or are self-funding suffer financial problems in procuring expensive ICT equipment. Relaxation should be made in norms for such institutes by the government. Getting qualified staff to maintain the ICT setup is also a problem. Grants for ICT infrastructure can be given by government through UGC, AICTE, University, etc.

- Though Printers are available in institutions but students are unable to benefit from them in majority of the cases. As possible solution for this problem the Management of institutions can is to install network printers which are attached to labs. To keep control on wastage,a special software to manage printing can be installed and each student can be given a quota of certain number ofpages for free print per semester or academic year. Beyond this quota the student can be made to pay at a subsidized per page rate.

- Management can procure Network Scanners are not easily available and the students don't frequently use it. In such a case, at least one scanner needs to be installed on any one computer per lab or per floor where students can use it.

- Laptop availability is another area where the institutions are under-performing. No statutory norms also don't mandate them. But all students don't have PCs at their home and some might want to borrow them. Institutions can have a few laptops with them which through Library orI.C.T. department can give to students for a limited period of time. Damages done to the laptop can be recovered from studentswho are responsible for them by the Management.

- Use of Trial-version software is quite prevalent and institutions are unable to manage this.. Even though institution's staff know the repercussions of this, but students still install them. Few possible reasons for this are: lack of open-source software, expensive license for certain software, problem in security policy of PCs which lets users to install any software, etc. There no single solution to this. Management should have strong penalties in their ICT security policy for defaulter users. Management through Network administrators must make it a point of not allow software to be installed by any other user other than the administrator using. This can be done by using group and local policies. Software manufacturers like Microsoft can give special limited period software license to students free or at subsidized prices through the institutions itself.

- There is an acute problem in the areas of Centralized Data Storage facilities. Nearly all universities and colleges in developed nations have one. Most Indian institutions don't even have one except the IIMs, IITs, to name a few. A.I.C.T.E. and other education regulatory bodies can mandate the presence of this facility. Depending the size of the institutions different levels of centralized Data Storage facilities can be proposed. Universities and Technical Campuses can be mandated to have a Data Center.

- I.C.T. Security Policies are under performing which means that Management of Institute's policies have failed when it comes to security. Management have either not been framed such policies or have not been implemented them properly. Student responses show that most colleges have failed to display them in relevant areas of the institution.

- I.C.T. Audit is one of the tools to make sure I.C.T. security policy is strictly implemented and can be used by both regulatory bodies and Institute's Management for exercising control. Data collected from this research also shows that I.C.T. Audit has not been found to be of much use in prevention of I.C.T. attacks and that most institutions don't even perform one periodically. Either Management of the institutes doesn't conduct them or their findings are not taken seriously. None of the regulatory bodies mandates such type of an audit.

- Absence of Antivirus of PCs and Servers in Professional Higher Education Institutions is a problem. A.I.C.T.E. and other statutory educational regulatory authorities must make Antivirus compulsory for 100% PCs and Servers.

- The PCs which are for public use in labs have an average life of 4-5 years. Rough use and continuous changing requirements for installation of latest software are important reasons for this. Absence of I.C.T. upgradation makes things worse. In countries like the USA, the PCs are changed every 3 years. Statutory Regulations must be made which mandate that all HigherTechnical education institutions upgrade their PCs and Servers at regular intervals.

- The minimum hardware requirements in terms of R.A.M., Harddisk, Processor should be provided in detail by regulatory bodies. While deciding the same, the hardware and software requirements of the course must be kept in mind. Software used by Engineering and MCA need more processing power whereas Management and Pharmacy don't need that much.

- There is lack of Hardware disposal policy. Old PCs and servers sold as scrap might contain hard disks which have vital data. Hardware disposal policy must include removal of the hard disk from Laptops, PCs and Servers before they are scrapped.

- As educational ERPs are still not installed / or not completely installed in all institutions especially small ones, data governance is a problem. A data governance policy needs to be created and should be implemented through ERP software so that RIGHT DATA is available to RIGHT PEOPLE at RIGHT TIME.

- I.C.T.security policy has not been able to play a major role in decreasing I.C.T. security attacks as per respondent's opinion in the study. There are few reasons for this. Firstly, in many institutions there is no such policy. Secondly, if the policy is there it is not displayed for user reference or might be it's contents are not effective or it is not actually implemented. I.C.T. policy need to be prepared compulsorily by Technical Staff after properly studying the requirements and taking feedback from all stakeholders. The policy needs to be displayed in all labs, classrooms and other relevant areas in the institutes. It must also mention the penalties for not following the provisions mentioned in it.

- Responses have shown that I.C.T. has not shown much returns on investments in the area of examination process. The reason behind both these problems is that in India we are still more dependent of Paper based work. If Universities and institute's Management conduct multiple choice questions pattern of examinations, the students will be bound to study more and depend less on low quality exam preparation guides to clear such exams. This will save teachers time w.r.t. answer books evaluation and will save paper stationary too.

- To improve return on investments in information Storage and access, we need to improve ERP software and storage & backup utilities. Doing this will also help the management in taking decisions effectively.

II) Areas which are doing well but then there is always a space for furtherimprovement

- Though vendors are giving support in implementation and/maintenance but most of them are shopkeepers who employee semi-skilled technical workers. Institutes must take services of large consulting firms or consultants on periodic basis as these are certified professional people and adhering to their advice will certainly reduce security risks and performance of network will definitely improve.

- It has been found that quite a number of institutions are using a mix of Branded and Non-Branded computers (PCs and Servers). But it is not clear in what ratio this is. A further study can be beneficial in this regard. Further, no norms have been set by any statutory education regulatory body which makes it compulsory for institutions to have only branded computers. These bodies, in the interest of both institutions and students at large, must make this compulsory to have only branded computers.

- Majority of Institutions has Wi-Fi network but there is a difference between majority and 100%. Students and teaching staff are frequently been found to be carrying laptops, smart phones and tablets in classes. During lecture sessions, the students can open websites and find out more what the teacher is teaching. Responses from students regarding Internet through Wi-Fi network is not very satisfactory. They have highlighted variousissues like presence of Wi-Fi network in only limited areas of the campus, very low internet bandwidth on Wi-Fi network, etc. In some institutions, the Management has not even provided Wi-Fi to students and is restricted to only Staff members and Management.A.I.C.T.E. and other statutory bodies need to make presence of Wi-Fi network necessary in Professional Higher technical Education Institutions and specify the areas where Wi-Fi devices be installed and also mandate the I.C.T. security that must be involved in it.

- Maintenance and Technical Support not been found to be 100% perfect. A.I.C.T.E. and other statutory bodies need to make it compulsory for all Higher Technical Education Institutions to have a minimum number of trained I.C.T. Support Staff who must carry at least a government recognized diploma in Computer stream and must also have an Industry certification from Cisco / linux, / Microsoft.Regular upgrade of their skills is also necessary like is practiced in industries. Also the number of I.C.T. support staff should be in ratio of computers. Current students can also be appointed on limited hours basis to work as support staff in labs like what is practiced in developed nations under EARN-AND-LEARN initiative.

- Licensed Academic software are available in institutions but some students specially from computer and engineering faculties want to study and practice on these software at home. Student versions of these software can be made available to such students.

- Respondents have opinioned for Increase in Internet bandwidth. Government should subsidize the Internet bandwidth rates for educational institutions especially the higher technical education ones. Internet bandwidth can be increased but monthly quota of upload and download can be fixed per user basis. This will decrease wastage of internet data by users.

- Mild and High intensity I.C.T. security attacks are less frequent but are not completely absent. Low intensity attacks are more frequent than the former ones. Relevant security tools and equipment need to be used from now itself so avoid turning low intensity attacks into high ones. User awareness needs to be increased. Also, User awareness regarding Cyber laws and relevant punishments under them need to be done.I.C.T. Security policy also need to be made compulsory in each institute. Unified Threat Management devise can be made compulsory in each institute.

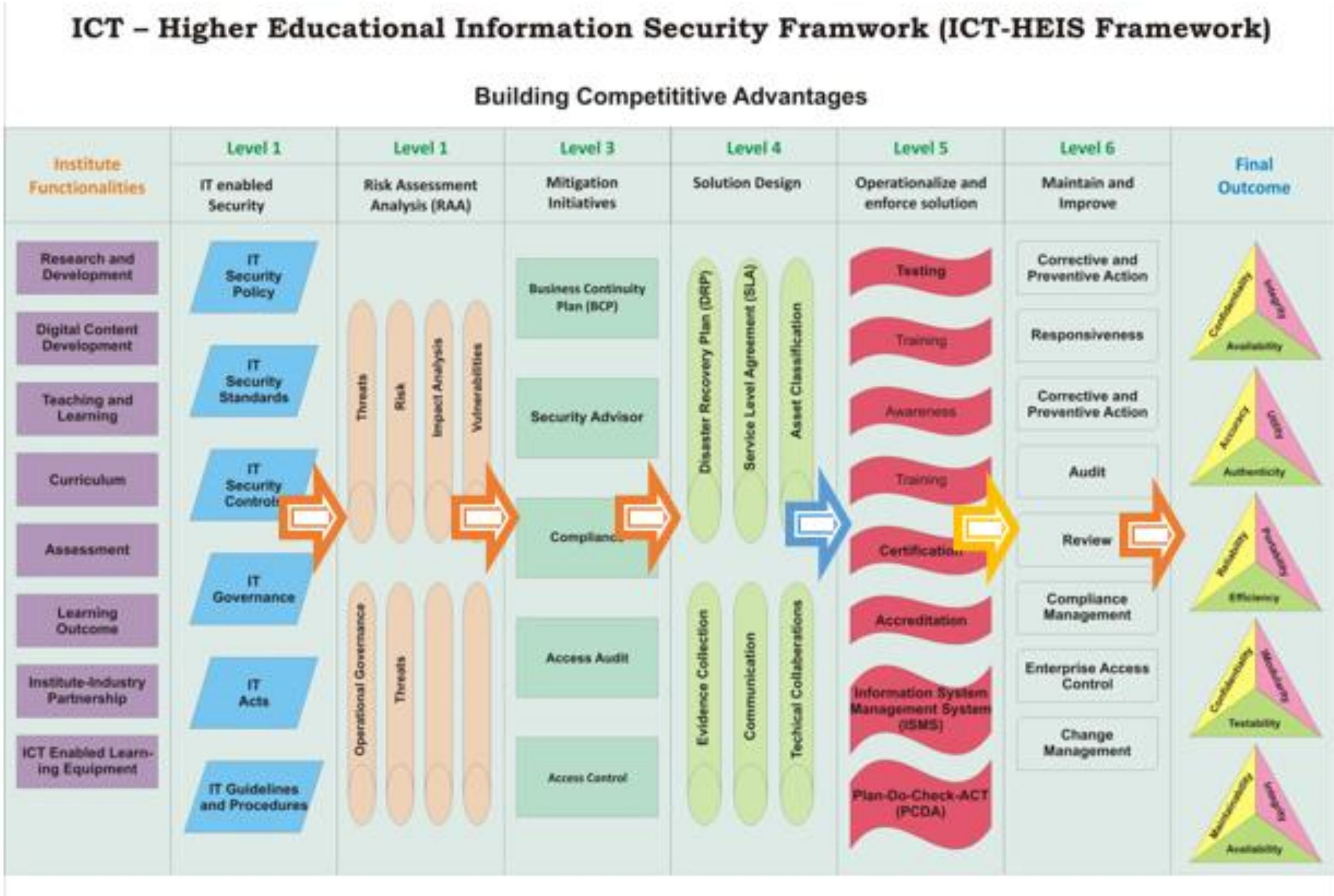
- I.C.T. budget needs to be set. A.I.C.T.E. and other educational regulatory bodies can set I.C.T. budget in ratio of student enrolment. To make sure that this amount is actually spent, a compliance report submission may be made compulsory.

- I.C.T. security is not only the responsibility of service providers but also the users. Stringent penalties can be levied on both Staff and students if negligence is found from their side.

III) A theoretical model to improve efficiency of I.C.T. in Institutions imparting Higher Technical Education:I.C.T.-Higher Educational Information Security (I.C.T.-HEIS) Framework

After studying the conclusions, the researcher has put forward a framework titled The I.C.T.-Higher Educational Infrastructure Security (HEIS) framework. This I.C.T.-HEIS framework has been designed with the objectives to providing Data governance, manage security issues, and aims at maintaining business continuity and build competitive advantage in the Professional higher technical Education Institutions.

Figure: 5.1:I.C.T.-Higher Educational Information Security (I.C.T.-HEIS) Framework



This frame work comprises 3 important components namely:

A) The Institutional Functionalities: Every higher technical education institution has certain aims and objective for which it has been established.These higher education aims and objectives are inculcated in very core on the institution's existence.

1. These include
2. Research & Development
3. Digital content development
4. Teaching and learning (including e-Learning)
5. Curriculum
6. Assessment
7. Learning objectives
8. Industry- institute relationship
9. I.C.T. enabled learning equipment
10. Investment
11. Open education

Most of these objectives are associated with data that needs to be secured and has to be made available to right person at the right time using properly managed data e-governance. Much of this data is confidential e.g. exam papers, student academic records, research documentation, etc.

B) The I.C.T. security architecture framework: This encompasses the core I.C.T. security functionality. It is composed of 7 layers arranged in a logical manner. Each of these layers provides a certain level of functionality w.r.t. I.C.T. security. The next layer provides remedies in case there is a problem with the current level of security provided.

1. **Layer 1: I.C.T.-Enabled security layer:** This is layer provides the physical and logical security. Strategic security decisions are taken. The

heads of institution along with Technical Staff, carve out the I.C.T. security policies. The effectively use the IT Security Standards IT guidelines and procedures while staying in the bounds of IT Acts of the land. IT governance coupled with data governance is incorporated as per the policies formulated. I.C.T. security controls like firewalls, access lists, routers, antivirus, etc. help in providing I.C.T. security in physical form. A brief description of these terms is given below:

a. IT security policy- administrative and technical security

b. IT security standards- guidelines, procedures and best practices ISO, FIZMA, GLEBA etc.

c. IT controls: Management, technical, and operational controls

d. IT Acts: legal recognition for electronic communication

e. IT Frameworks and infrastructure:COBIT, ITIL, CMM, 6-sigma

2. **Layer 2: Risk assessment and analysis:** Though utmost care and effort is made in layer 1 to negate the possibility of I.C.T. security attacks, still no solution is 100% failure proof. The Risk assessment and analysis layer identifies and accesses the types of risk coming by various ways and their impact on higher educational infrastructure in terms of security.

   This layer includes the following sub processes:

   a. **Threats identification**: The threats to security may include one or more of the following: Virus, Hacking, Spyware, Natural Calamities, Rootkit, Backdoor attacks, threats from internal sources, etc.

   b. **Vulnerabilities identification**: These are the open areas or exposed areas which could invite or transform into Threats. These may include poor network design, poor passwords, poor server and firewall configurations to name a few.

   c. **Riskidentification**: Here we identify the risks or damages that could happen in case the threats and vulnerabilities transform into a real I.C.T. security attack. Risks associated with I.C.T. security attacks on Higher Technical Education institutions include one or more of the following: Cyber defamation, spoofing, economic crimes, IPR infringement

d. **Impact analysis:** This sub-process involves the analysis of level of damage which could be the outcome of I.C.T. security attack. The impacts may include financial impact, impact on goodwill, physical impact, privacy impact.

   Impact analysis can be carried on 3 Levels. (i) low level analysis, (ii) mid-level analysis, and (iii) high middle analysis.

e. **Operational governance analysis:** Here analysis is done to find the overall impact on the business of the institution. Main analysis is about finding the impact of I.C.T. security attack on overall operational governance of the institution.

3. **Layer 3: Risk Mitigation initiatives:**To moderate the immediate effects of I.C.T. security attacks, at this stages, we design and install appropriate security controls at right place so that C-I-Aof educational infrastructure is achieved. These are the standard procedures or immediate steps to reduce the effect of an I.C.T. attack which need to be followed in case an I.C.T. security attack ever happens. It includes:

   a. **BCP (Business Continuity Plan)**: to ensure that business runs during and post-disaster.

   b. **Security advisor**: to work as consultant in identifying the exact source of attack and propose immediate remedy to control the attack.

   c. **Access audit**: user access audit to find any deviations which transformed threats and vulnerabilities into actual security attack.

   d. **Access control**: immediate review of authentication-authorization-accounting to find vulnerabilities and take necessary changes.

   e. **Compliance:** government and regulatory bodies may give certain norms to comply to mitigate risks. Institutions need to comply to them.

4. **Layer 4: Solution Design:**After holistic analysis of threats, risks and suggested control, following solution is designed and is expected to the practiced by the institution so that similar I.C.T. security compromise doesn't happen.

   a. **DRP (Disaster Recovery Plan):** This is one very important document. This document states how to recover from the aftermath of the security attack. This document provides various remedies to bring the institution and its business processes back on trackof. This document states the recovery steps in very specific terms and identifies the milestones that need to be attained in time-bound manner.

   b. **Asset classification**: based upon impact analysis, need to categories assets according to their criticality. This could be Low Critical assets, Mid-level Critical asset, Highly critical asset.

   c. **SLA (Service Level Agreement)**: For the continuity of business processes, the I.C.T. infrastructure should have a minimum uptime guarantee. Certain aspects of I.C.T. infrastructure can be managed by the institution using internal sources but others need 3rd party support. When considering SLA one must consider the Asset Classification of the assets. Outsourcing the maintenance by Entering into AMC contracts and Service Level Agreements with Service centers, etc. provides Service continuity with established service design, service delivery, service support round the clock.

   d. **Evidence collection:**There needs to be a mechanism in place to look for evidence of I.C.T. security breach round the clock. Physical analysis of premises, log records of servers, etc. and employing Intrusion Detection Systems provide mechanism of collecting evidence of occurrence of I.C.T. security breach.

   e. **Communication:**There needs to be a communication system in place which is capable of communicating the occurrence of I.C.T. security attack or creation of possible vulnerability which could lead to I.C.T. security attack. This mechanism should also be able to communicate the remedies to the users, support staff and administrators of I.C.T. along with an effective feedback system to understand the effectiveness of steps taken to counter I.C.T. attacks.

5. **Layer 5: Operationalize and enforce solution:**This layer is involved in actual implementation of solutions which have been devised at layer 4.

    a. **Testing:** The first part of this step involves testing of the proposed design solution. This involves the implementation of solution for testing purpose in either of the 2 ways: (i) Small scale implementation of proposed solutions in a step-to-step manner. This involves Implement—Wait-and-watch--- Proceed mechanism. (ii) Test the solution in laboratory environment or test equipment to find the possible outcomes. This gives time to I.C.T. administrators to ensure that proposed solutions give a positive results.

    b. **Training:** Before the solution is made operational, trained manpower is needed to implement it and then work on it on day-to-day basis. Training programs and Training Manuals need to be prepared. These must be accompanied with user manuals.

    c. **Awareness:** Awareness regarding the existence of the solution need to be created among the stakeholders and users. Awareness creation can be made by way of User interaction programs, monthly student magazines, etc.

    d. **Certification:** Users / administrators can be made to undergo specialized vendor trainings and certifications like Microsoft certification, Cisco certification, etc. This will ensure that the solution is in professional hands.

    e. **Accreditation:** Institution needs to go-in for accreditations like NBA (academic), and other I.C.T. security related accreditations like ……

    f. **ISMS (Information Security Management System):** Here the framework uses the Information Security Management System which is the ISO 27001:2005 international standard of best practices in the field of establishing, maintaining, and improving security programs in organizations and uses integrated processes to manage the administration of security program policies and procedures.

As part of ISMS, the educational institution needs to continuously review its security and constantly improve it. It required that all I.C.T. security related activities are recorded and there is periodic audit of these activities. To increase awareness about best practices, the institution is required to conduct training and awareness programs w.r.t. best practices needed under security management and its compliance.

6. **Layer 6: Maintain and improve infrastructure security:**Once the solutions have been operationalized, it is important that continuous maintenance and improvement is taken. For this purpose following steps need be incorporated:

   a. **Corrective & preventive action:**For the success of any system, it is important to analyze the performance of the system and if negative deviations in performance are found then corrective actions are needed to rectify the system. Preventive actions are needed to prevent any security hazards in future.

   b. **Responsiveness:**First of all the System should be so robust that no security attacks ever effects it. But if even there is a compromise in the security then response to such attacks should be quick and effective to minimize losses, destruction and down-time.

   c. **Audit:**There should be frequent internal and external security audits. These help in timely identification of prescribed procedures and finding security breaches which might have gone un-noticed.

   d. **Review:** After a few days of operation of the system, periodic reviews should be conducted. In this phase, audit reports should be studies, various failure reports must be examined. Apart from this, feedback should be taken from I.C.T. administrators on the operation and maintenance aspect. Feedback should also be taken from users and other stakeholders.

e. **Compliance Management:**It is beneficial for institutions to go in for standardization certifications like ISO. Other voluntary compliances could be NBA, NAAC, etc. while mandatory compliance include UGC, A.I.C.T.E., DTE and Affiliating university compliances. International Telecommunication Union - Telecommunication Standardization Sector (ITU-T),International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) are some of the international standardization organizations for I.C.T..

Being compliant to such compliance standards provides feedback on system operations and reduces vulnerabilities in the system.

f. **Enterprise Access Control:**Enterprise Access Control must be implemented across the institution. Access Right must implemented and duly audited. All users and employees of the institution should not have the same access level. Monitor real-time access logs and dashboards to see who accesses the network, when and what.

C) The final Outcome: If the Framework is properly and successfully implemented in the I.C.T. system, the institution gets the following TRIADS:

TRIAD 1: Confidentiality-Integrity-Availability

a. **Confidentiality**: The framework provides data governance through which limits access to information.

b. **Integrity**: As the data is secured and the framework is able to guarantee that the information is trustworthy and accurate.

c. **Availability**: Framework assures reliable access to the information by authorized people 24*7.

TRIAD 2: Accuracy-Utility-Authenticity

a. **Accuracy**: The Framework assures that the data values stored are the correct values and thus assures data quality.

b. **Utility**: The framework aims at timely delivering complete and accurate referenced data. This data is not only for running routine processes of the institute but also involves data for use in critical regulatory reporting, transaction processing and risk management. At the same time it minimizes un-necessary costs for the institutions in terms of time and money.

c. **Authenticity**: framework provides authenticity to the data. It ensures that the data source is correct and what it claims to be or what it is claimed to be.

TRIAD 3: Reliability-Portability-Efficiency

a. **Reliability**: Framework ensures that data are reasonably complete and accurate. Framework ensures that data is checked at the time of input / import itself.

b. **Portability:** The framework strives to create I.C.T. infrastructure especially the databases and software (e.g. ERP) in such a way that it is easy to move, copy or transfer data easily from one database, storage or IT environment to another.

c. **Efficiency:** The framework ensures that there is efficiency in storage, access, filtering, sharing, etc. of data while not compromising with the transparency to the user. Managing storage growth, increasing amount of usable storage, and reducing overall storage costs is at the core of the framework's objectives.

TRIAD 4: Maintainability—Modularity-Testability:

a. **Maintainability:** The framework strives to create a high probability of repairing a failed component or system or software or any part of the institute's I.C.T. infrastructure. It ensures that it is restored or repaired to a specified condition within a specific period of time.

b. **Modularity**: The framework ensures that the software used in the institutions (especially the ERP systems) are modularized and inter-relation of the parts of a software package is smooth. Also, modularity in other aspects of I.C.T. infrastructure assures that all pieces of the I.C.T. infrastructure except the affected ones remain functional.

c. **Testability:** Testability is a way of conducting trials of the system and its various components. It determines and guarantees the quality and genuineness of the I.C.T. infrastructure.

TRIAD 5: Completeness-operability-simplicity

a. Completeness: The framework offers availability of all relevant data necessary to meet the current and future information demand. It proposes inclusion of data validation processes so that at the time of input of data itself, the complete data is stored.

b. Operability: The framework strives to provide mechanism that ensures that data is stored in such a manner that it can be later used directly, without additional processing: restructuring, conversion, etc. The software that are going to be used in the institutions will store data in most common formats like SQL and XML which can be easy be read by other software.

c. Simplicity: To maintain simplicity of data, the institutions data collection sources will be narrowed down so that the complex processes for gathering data and turning it into meaningful information become simpler.The framework aims at cutting down the extra steps involved in data collection and processing.

5.4 LIMITATION OF THE STUDY:

This research study, like other research studies has certain limitations. Some of these are:

- It covers geographical area Pune which is quite industrially and academically developed. Findings could have been different in case of smaller cities.
- Certain deeper technical aspects of PCs and Servers have not been covered as the study is more Management oriented.
- Medical institutions and simple Undergraduate courses like BA, B.Com, etc colleges have not been covered.
- University which is the highest body for imparting higher education has not been individually studied.

5.5 FURTHER STUDY:

The Researcher wanted to conduct a deeper study on the I.C.T. infrastructure and its security but due to time constraint this was not possible. Thus, this study has left open certain areas for research and created new ones which researcher would like to himself undertake as post-doctoral research or they can be used by researchers in future. Some of these areas are:

- Study of I.C.T. infrastructure in agricultural educational institutions located in Rural areas.
- Study of I.C.T. infrastructure in Diploma-level educational institutions located.
- A study of I.C.T. security audit system in educational institutions
- A study of I.C.T. infrastructure in schools / graduate level colleges in tier-2 cities.

5.6 CONTRIBUTION OF RESEARCH TO EXISTING BODY OF KNOWLEDGE

The suggestions will give clear cut guidelines for managing the implementation and maintenance of I.C.T. which will become the baseline for the higher technical education facilitators in the country.

Government has made many policies relevant to this area of study but have some problems at implementation level, these have been pointed out and remedies have been suggested in the study.

SUMMARY:

In this chapter the researcher has described various finding which the researcher has observed after analyzing the data collected. Relevant conclusions have been arrived upon and based on these the researcher suggested certain solutions.

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ANNEXURE A - QUESTIONNAIRE FOR HEAD OF INSTITUTE

Questionnaire for the Head of Institute who are imparting Higher Technical education courses. The researcher is conducting survey and recording information to carry out research which will help researcher to come up with suitable outcome for the Institutes and Universities in Pune Region. The information collected here is only for research purpose and in no way will be used for commercial purpose.

1. **Type of Institution:**
   (1)Government/Statutory University [ ] (2)Deemed / Private University [ ]
   (3)Autonomous College [ ] (4)Institution of National Importance [ ]
   (5)Affiliated College [ ]
   (6)If affiliated institution: Please specify University of Affiliation:____________________

2. **Types of Courses** : (1) Graduate [ ] (2)Post Graduate [ ]
3. **Approval from AICTE** : (1)Yes [ ] (2)No [ ]
4. **Total Number of Students(all years):**
   (1) Upto 300 [ ] (2) More than 300 but less than 600 [ ]
   (3) More than 600 but less than 900 [ ] (4) More than 900 but less than 1200 [ ]
   (5) More than 1200 but less than 1500 [ ] (6) Above 1500 [ ]
5. **Government Support:**
   Aided [ ]
   Unaided [ ]
6. **Location** : (1) Urban [ ]
   (2) Rural [ ]
7. **Courses Conducted (AICTE Approved only): (*Select ONE only*)**
   (1)Engineering / Architecture [ ] (1) Management / Hotel Management / MCA [ ] (3) Pharmacy [ ]
8. **Total Number of Staff members: (*select only ONE*)**
   1. Up to 50 [ ] **2.** More than 50 but less than 100 [ ]
   3. More than 100 but less than 150 [ ] **4.** More than 150 but less than 200 [ ]
   5. More than 200 [ ]
9. **According to which norms have you created your ICT infrastructure?**
   1. AICTE Norms [ ] **2.** DTE Norms [ ]
   3. Government Norms [ ] **4.** UGC [ ]
   5. Affiliating University [ ] [ ]
10. **What type of ICT implementation and maintenance support did your organization go for?**
   1. Large general consulting firm [ ] **2.** Independent specialist consultants [ ]
   3. Vendor support [ ] **4.** Only internal resources [ ]
11. **Total number of PCs available in your institution?**
   1. Up to 150 PCs [ ] **2.** 151 PCs to 300 PCs [ ]
   3. 301PCs to 450 PCs [ ] **4.** 451 PCsand above [ ]
12. **Total Number of Technical Staff members:** (*select only ONE*)
   1. Upto 5 [ ] 2. More than 5 but less than10 [ ]
   3. More than 10 but less than 15 [ ] 4. More than 15 but less than 20 [ ]
   5. More than 100 [ ] [ ]
13. **What type of PCs and Servers does your institution have?**
   (1) Branded [ ] (2) Non-branded [ ] (3) Both [ ]
14. **What is the speed of internet connection at your institution?**
   1. No Internet Connection [ ] **2.** Below 5 Mbps [ ]
   3. 5 to 10 Mbps [ ] **4.** 10 Mbps to 15 Mbps [ ]
   5. 15 Mbps and above [ ]

15. To what extent are you satisfied with the overall ICT infrastructure security?

1 Strongly Dissatisfied	2 Dissatisfied	3 Can't say	4 Satisfied	5 Strongly Satisfied
[ ]	[ ]	[ ]	[ ]	[ ]

16. To what extent are you satisfied with the overall ICT Digital assets security?

1 Strongly Dissatisfied	2 Dissatisfied	3 Can't say	4 Satisfied	5 Strongly Satisfied
[ ]	[ ]	[ ]	[ ]	[ ]

17. Rate on the scale of 1 to 5 (1-lowest and 5-highest) the level of ICT security attacks your organization has received

Sl. Nbr.	Level of Attack	Rate
1	**Low intensity attacks**(low operational, data and financial loss)	
2	**Mild intensity attacks**(mild operational, data and financial loss)	
3	**High intensity attacks**(high operational, data and financial loss)	

18. What is your role in Security policy making?

1. No role [ ] 2. Consultative [ ] 3. Lone Creator [ ] 4. Final decision maker [ ]

19. Do you have an ICT up-gradation policy in your organization? Yes **[ ]** Cant' say [ ]No [ ]

20. On how many servers do you have licensed antivirus?(1)None[ ] (2) Few [ ] (3)All[ ]

21. On how many PCs do you have licensed antivirus?None[ ] (2) Few [ ] (3) All[ ]

22. What Percentage of Annual Budget is set aside for ICT? (*Select only ONE option***)**

1. Less than 5 % of annual budget [ ]
2. More than 5% but less than 10 % of annual budget [ ]
3. More than 10% but less than 15% of annual budget [ ]
4. More than 15% but less than 20% of annual budget [ ]
5. 20% and above of annual budget [ ]
6. Can't Say [ ]

23. What Percentage of Annual Budget set aside for New purchases, Up-gradation, etc. of ICT is actually used?

1. Less than 20 % but less than sanctioned ICT budget [ ]
2. More than 20% but less than 40 % of sanctioned ICT budget [ ]
3. More than 40% but less than 60% of sanctioned ICT budget [ ]
4. More than 60% but less than 80% of sanctioned ICT budget [ ]
5. 80% and above of sanctioned ICT budget [ ]
6. Can't Say [ ]

24. Investment in ICT infrastructure is every penny worth spent. Please give your view on this?

1 Strongly disagree	2 Disagree	3 Can't say	4 Agree	5 Strongly Agree

25. Kindly state the extent of benefits or maximum Return of Investments on ICT for the following areas?

Sl. No.	**Description**	**1** Very Low	**2** Low	**3** Can't say (Neutral)	**4** High	**5** Very High
1	Examination process	[ ]	[ ]	[ ]	[ ]	[ ]
2	Communication	[ ]	[ ]	[ ]	[ ]	[ ]
3	Manpower (Teaching, Non-teaching, etc.) staff	[ ]	[ ]	[ ]	[ ]	[ ]
4	Research	[ ]	[ ]	[ ]	[ ]	[ ]
5	Administration	[ ]	[ ]	[ ]	[ ]	[ ]
6	Decision making	[ ]	[ ]	[ ]	[ ]	[ ]
7	Stationary (e.g. paperless office)	[ ]	[ ]	[ ]	[ ]	[ ]
8	Information storage and access	[ ]	[ ]	[ ]	[ ]	[ ]
9	Automation and integration	[ ]	[ ]	[ ]	[ ]	[ ]
10	Others	[ ]	[ ]	[ ]	[ ]	[ ]

26. State extent you agree with benefits provided by implementation of ICT in your higher technical education institution. (*Select only one option per row***)**

Sl. No.	**Description of benefit**	**1** Strongly disagree	**2** Disagree	**3** Can't say (Neutral)	**4** Agree	**5** Strongly Agree
Strategic benefits						
1	Maximize resource utilization including learning resources					
2	Standardize processes					
3	Simplification and decentralization decision making					
4	Reduced need of direct attention					
5	Investment decisions					
6	Result delivery					
7	Enhanced public profile of institution **(Brand Building)**					
8	Expand expertise base					
9	knowledge Sharing					
10	Efficiency and accuracy in delivery					
11	Identification of areas which are consuming time and money					
12	Attract more students and expert faculty members					
13	Increase variety and depth in research and innovation					
14	Understand strategic needs					
15	Understand changing environment and requirements					
16	Better co-ordination of activities					
17	Effective communication between staff, students and other stakeholders					
18	Staff Skill development					
19	Strategic partnering with external institutions					
Monetary Benefits						
20	Profit margin maximization and wealth creation					
21	Reduced labour costs					
22	Reduced administrative costs					
23	Reduction in teaching-learning costs					
24	Reduced payback period					
25	Increase in admissions					
26	Facility rentals for corporate training and online exams					

Respondent Name: -- College Name : --

ANNEXURE B - Questionnaire for Full-Time Teaching Staff

Questionnaire for the Full-timeTeaching Staff of Institutes and Universities who are imparting Higher Technical education courses. The researcher is conducting survey and recording information to carry out research which will help researcher to come up with suitable outcome for the Institutes and Universities in and around Pune District. The information collected here is only for research purpose and in no way will be used for commercial purpose.

1. Type of Institution:

(1)Government/Statutory University [ ] (2)Deemed / Private University [ ]
(3)Autonomous College [ ] (4)Institution of National Importance [ ]
(5)Affiliated College [ ]
(6)If affiliated institution: Please specify University of Affiliation:___________________

2. Types of Courses : (2)Graduate [ ] (2)Post Graduate [ ] **3. Approval by AICTE** : (1)Yes [ ] (2)No [ ]

4. Total Number of Students(all years):

(1) Upto 300	[ ]	(2) More than 300 but less than 600	[ ]
(3) More than 600 but less than 900	[ ]	(4) More than 900 but less than 1200	[ ]
(5) More than 1200 but less than 1500	[ ]	(6) Above 1500	[ ]

5. Government Support:
Aided [ ]
Unaided [ ]

6. Location : (1) Urban [ ] (2) Rural [ ]

7. Courses Conducted (AICTE Approved only): (*Select ONE only*)

(1)Engineering / Architecture [ ] (3) Management / Hotel Management/ MCA [ ] (3)Pharmacy [ ]

8. l Number of Staff members: (*Select only one option*)

1. Up to 50 [ ] **2.** More than 50 but less than 100 [ ]
3. More than 100 but less than 150 [ ] **4.** More than 150 but less than 200 [ ]
5. More than 200 [ ]

9. Select only one option which best describes your institution's geographical setup:*(select only one)*

1) Single institute located only in one single building [ ]
2) Group of institutions located in same campus [ ]
3) Group of institutions spread in 2 or more campuses located in same city [ ]
4) Group of institutions spread in 2 or more campuses located in different cities [ ]

10. l number of PCs available in your institution?(*Select only one option*)

1. Up to 150 PCs [ ] **2.** 151 PCs to 300 PCs [ ]
3. 301 PCs to 450 PCs [ ] **4.** 451 PCs and above [ ]

11 **Are Laptops, printers, etc.available to students and staff for use? Give frequency of availability.**

Type	**1 Never**	**2 sometimes**	**3 Neutral**	**4 Frequently**	**5 Very Frequently**
PC	[ ]	[ ]	[ ]	[ ]	[ ]
Laptop	[ ]	[ ]	[ ]	[ ]	[ ]
Scanner	[ ]	[ ]	[ ]	[ ]	[ ]
printer	[ ]	[ ]	[ ]	[ ]	[ ]

12 **What type of PCs and Servers does your institution have?**

Branded [ ] (2) Non-branded [ ] (3) Both [ ]

13. **What type of software your organization is using? Please give your opinion about frequency of its use.(*Select only one option per row*)**

Software Type	1 Never	2 sometimes	3 Neutral	4 Frequently	5 Very Frequently
In-house developed	[ ]	[ ]	[ ]	[ ]	[ ]
Open-source	[ ]	[ ]	[ ]	[ ]	[ ]
Trial version / Unlicensed	[ ]	[ ]	[ ]	[ ]	[ ]
Licensed	[ ]	[ ]	[ ]	[ ]	[ ]
Any other	[ ]	[ ]	[ ]	[ ]	[ ]

14. **rding to which norms have you created your ICT infrastructure?(*Select only one option*)**

a.	AICTE Norms	[ ]	**b.**	DTE Norms	[ ]
c.	Government Norms	[ ]	**d.**	UGC	[ ]
e.	Affiliating University	[ ]	**f.**	Others ____________________	[ ]

15. What is the purpose you are using institution's ICT for?

Sl. No.	Description	1 Never	2 Sometimes	3 Neutral	4 Frequently	5 Very Frequently
1	Email	[ ]	[ ]	[ ]	[ ]	[ ]
2	Social Networking	[ ]	[ ]	[ ]	[ ]	[ ]
3	Newspaper reading	[ ]	[ ]	[ ]	[ ]	[ ]
4	Job searching	[ ]	[ ]	[ ]	[ ]	[ ]
5	Listening to songs and videos	[ ]	[ ]	[ ]	[ ]	[ ]
6	Lecture preparation	[ ]	[ ]	[ ]	[ ]	[ ]
7	View online lectures	[ ]	[ ]	[ ]	[ ]	[ ]
8	Research work	[ ]	[ ]	[ ]	[ ]	[ ]
9	Administrative work	[ ]	[ ]	[ ]	[ ]	[ ]
10	Exam work ,	[ ]	[ ]	[ ]	[ ]	[ ]
11	Lecture delivery / Practical session	[ ]	[ ]	[ ]	[ ]	[ ]
12	Others	[ ]	[ ]	[ ]	[ ]	[ ]

16. State the extent to which you yourself aresatisfied for the following ICT services. (*Select only one option per row***)**

Sl. No.	Service Description	1 Strongly Dissatisfied	2 Dissatisfied	3 Neutral	4 Satisfied	5 Strongly Satisfied
1	Internet services through wired network	[ ]	[ ]	[ ]	[ ]	[ ]
2	Internet services through Wi-Fi	[ ]	[ ]	[ ]	[ ]	[ ]
3	Maintenance / Technical support	[ ]	[ ]	[ ]	[ ]	[ ]
4	Administration software	[ ]	[ ]	[ ]	[ ]	[ ]
Sl. No.	**Service Description**	**1 Strongly Dissatisfied**	**2 Dissatisfied**	**3 Neutral**	**4 Satisfied**	**5 Strongly Satisfied**
5	Academic application software	[ ]	[ ]	[ ]	[ ]	[ ]
6	ICT Security policies and Security facility	[ ]	[ ]	[ ]	[ ]	[ ]
7	Storage and Backup utilities	[ ]	[ ]	[ ]	[ ]	[ ]
8	Communication facilities (email, SMS, alert messaging, etc.)	[ ]	[ ]	[ ]	[ ]	[ ]

17. Which of the following measures you think can or have proved to help in improving user satisfaction. (*Select only one option per row***)**

Sl. No.	Description	No	Can't say	Yes
1	Training of technical support staff	[ ]	[ ]	[ ]
2	Increase in number of technical support staff	[ ]	[ ]	[ ]
3	Replace old PCs, laptops, etc.	[ ]	[ ]	[ ]
4	Provide after-hour lab facility	[ ]	[ ]	[ ]
5	Leniency in access and content control on internet usage	[ ]	[ ]	[ ]
6	Increase Internet bandwidth and making available on all PCs	[ ]	[ ]	[ ]
7	Anti-virus	[ ]	[ ]	[ ]
8	ERP and other software used for teaching-learning	[ ]	[ ]	[ ]
9.	More Frequent updating of organization's ICT Security Policy in consultation with stakeholders including staff and students	[ ]	[ ]	[ ]
10.	Any other: _______________________________	[ ]	[ ]	[ ]

18. To what extent are you satisfied with the overall ICT infrastructure security?

1 Strongly Dissatisfied	2Dissatisfied	3 Can't say	4 Satisfied	5 Strongly Satisfied

19. To what extent are you satisfied with the overall ICT Digital assets security?

1 Strongly Dissatisfied	2 Dissatisfied	3 Can't say	4 Satisfied	5 Strongly Satisfied

20. Rate on the scale of 1 to 5(1-lowest and 5-highest) the level of ICT security attacks your organization has received

Sl. No.	Level of Attack	Rating (1 to 5 only)
1	**Low intensity attacks**(low operational, data and financial loss)	[ ]
2	**Mild intensity attacks**(mild operational, data and financial loss)	[ ]
3	**High intensity attacks**(high operational, data and financial loss)	[ ]

21. Do you have an ICT up-gradation policy in your organization? Yes **[ ]** No [ ]Can't say [ ]

22. Rate from 1 to 5 the extent success for the followingfactors in being able to reduce / prevent ICT security lapse or attack:(1-lowest t 5 highest)

Sl. No.	Description of Factors	Rate
1	Institution's ICT security policy is able to secure ICT infrastructure and data assets	[ ]
2	Technical staff able to manage ICT infrastructure and its security	[ ]
3	Security audit able to find gaps in ICT security	[ ]
4	Physical security of campus / building like CCTV, biometric access controls	[ ]
5	Educating of staff and students about ICT laws and Best Practices	[ ]
6	Antivirus, firewall, auto-updates, etc.	[ ]

23. Give your views regarding the areas which you think need to be address to improve ICT security in your organization? (Select one or more)

Sl. No.	Areas of Improvement	No	Can't say	Yes
1	User Awareness about cyber laws	[ ]	[ ]	[ ]
2	Delegation and Fixation of responsibility	[ ]	[ ]	[ ]
3	Stringent penalties	[ ]	[ ]	[ ]
4	Train users to identify ICT security risks	[ ]	[ ]	[ ]
5	Understanding and awareness of available security responses	[ ]	[ ]	[ ]
6	Identification and blocking loopholes in security	[ ]	[ ]	[ ]
7	Changes in routines, beliefs and informal norms used in the organization	[ ]	[ ]	[ ]

24. What Percentage of Annual Budget is set aside for ICT? (*Select only ONE option*)

1. Less than 5 % of annual budget [ ]
2. More than 5% but less than 10 % of annual budget [ ]
3. More than 10% but less than 15% of annual budget [ ]
4. More than 15% but less than 20% of annual budget [ ]
5. 20% and above of annual budget [ ]
6. Can't Say [ ]

25 What Percentage of Annual Budget set aside for New purchases, Up-gradation, etc. of ICT is actually used? (*Select only ONE option*)

1. Less than 20 % but less than sanctioned ICT budget [ ]
2. More than 20% but less than 40 % of sanctioned ICT budget [ ]
3. More than 40% but less than 60% of sanctioned ICT budget [ ]
4. More than 60% but less than 80% of sanctioned ICT budget [ ]
5. 80% and above of sanctioned ICT budget [ ]
6. Can't Say [ ]

26. Investment in ICT infrastructure is every penny worth spent.

1 Strongly disagree	**2** Disagree	**3** Can't say	**4** Agree	**5** Strongly Agree
☐	☐	☐	☐	☐

27.State the extent of benefits or maximum Return of Investments on ICT for the following areas?(*Select only one option per row***)**

Sl. No.	Description	1 Very Low	2 Low	3 Neutral	4 High	5 Very High
1	Examination process	[ ]	[ ]	[ ]	[ ]	[ ]
2	Communication	[ ]	[ ]	[ ]	[ ]	[ ]
3	Manpower (Teaching, Non-teaching, etc.) staff	[ ]	[ ]	[ ]	[ ]	[ ]
4	Research	[ ]	[ ]	[ ]	[ ]	[ ]
5	Administration	[ ]	[ ]	[ ]	[ ]	[ ]
6	Decision making	[ ]	[ ]	[ ]	[ ]	[ ]
7	Stationary (e.g. paperless office)	[ ]	[ ]	[ ]	[ ]	[ ]
8	Information storage and access	[ ]	[ ]	[ ]	[ ]	[ ]
9	Automation and integration	[ ]	[ ]	[ ]	[ ]	[ ]
10	Others	[ ]	[ ]	[ ]	[ ]	[ ]

28. State extent you agree with benefits provided by implementation of ICT in your higher technical educationinstitution.(*Select only one option per row***)**

Sl. No.	Description of benefit	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
Strategic benefits						
1	Maximize resource utilization including learning resources	[ ]	[ ]	[ ]	[ ]	[ ]
2	Standardize processes	[ ]	[ ]	[ ]	[ ]	[ ]
3	Simplification and decentralization decision making	[ ]	[ ]	[ ]	[ ]	[ ]
4	Reduced need of direct attention	[ ]	[ ]	[ ]	[ ]	[ ]
5	Investment decisions	[ ]	[ ]	[ ]	[ ]	[ ]
6	Result delivery	[ ]	[ ]	[ ]	[ ]	[ ]
7	Brand Building	[ ]	[ ]	[ ]	[ ]	[ ]
8	Expand expertise base	[ ]	[ ]	[ ]	[ ]	[ ]
9	knowledge Sharing	[ ]	[ ]	[ ]	[ ]	[ ]
10	Efficiency and accuracy in delivery	[ ]	[ ]	[ ]	[ ]	[ ]
11	Identification of areas which are consuming time and money	[ ]	[ ]	[ ]	[ ]	[ ]
12	Attract more students and expert faculty members	[ ]	[ ]	[ ]	[ ]	[ ]
13	Increase variety and depth in research and innovation	[ ]	[ ]	[ ]	[ ]	[ ]
14	Understand strategic needs	[ ]	[ ]	[ ]	[ ]	[ ]
15	Understand changing environment and requirements	[ ]	[ ]	[ ]	[ ]	[ ]
16	Better co-ordination of activities	[ ]	[ ]	[ ]	[ ]	[ ]
17	Effective communication between staff, students and other stakeholders	[ ]	[ ]	[ ]	[ ]	[ ]
18	Staff Skill development	[ ]	[ ]	[ ]	[ ]	[ ]
19	Strategic partnering with external institutions	[ ]	[ ]	[ ]	[ ]	[ ]
Monetary Benefits						
20	Profit margin maximization and wealth creation	[ ]	[ ]	[ ]	[ ]	[ ]
21	Reduced labour costs	[ ]	[ ]	[ ]	[ ]	[ ]
22	Reduced administrative costs	[ ]	[ ]	[ ]	[ ]	[ ]
23	Reduction in teaching-learning costs	[ ]	[ ]	[ ]	[ ]	[ ]
24	Reduced payback period	[ ]	[ ]	[ ]	[ ]	[ ]
25	Increase in admissions	[ ]	[ ]	[ ]	[ ]	[ ]
26	Facility rentals for corporate training and online exams	[ ]	[ ]	[ ]	[ ]	[ ]

Any other remarks:

____

____

Other General Information

A.	**Name: of organization:** ____ (Optional)
B.	**Address**(Optional)**:** ____ **City:** ______________________ **Website:** _____________________________
C. **D.**	**Name of Respondent:** ____ **Designation** **:Teaching Staff** [ ]

ANNEXURE C - QUESTIONNAIRE FOR FULL-TIME STUDENTS

Questionnaire for the Students of Institutes and Universities who are imparting Higher Technical education courses. The researcher is conducting survey and recording information to carry out research which will help researcher to come up with suitable outcome for the Institutes and Universities in Pune region. The information collected here is only for research purpose and in no way will be used for commercial purpose.

1. Select Type of Institution you are studying in :

(1)Government/Statutory University [ ] (2)Deemed / Private University [ ]
(3)Autonomous College [ ] (4)Institution of National Importance [ ]
(5)Affiliated College [ ]
(6)If affiliated institution: Please specify University of Affiliation:____________________

2. Course Level : (4) UG [ ] (2)PG [ ]

3. l Number of Students(all years): (*Select only one option***)**

(1) Upto 300 [ ] (2) More than 300 but less than 600 [ ]
(3) More than 600 but less than 900 [ ] (4) More than 900 but less than 1200 [ ]
(5) More than 1200 but less than 1500 [ ] (6) Above 1500 [ ]

4. Which course are you studying: (*select only ONE*)

(1)Engineering/Architecture [ ] (5) Management / Hotel Management / MCA [ ]
(3)Pharmacy [ ] [ ]

5. Total Number of Staff members: (*select only ONE*)

1. Up to 50 staff members [ ] **2.** More than 50 but less than 100 [ ]
3. More than 100 but less than 150 [ ] **4.** More than 150 but less than 200 [ ]
5. More than 200 staff members [ ]

6. Institute Location :(1) Urban [ ](2) Rural [ ]

7. **Total number of PCs available in your institution? (***Select only ONE***)**

1. Up to 150 PCs [ ] **2.** 151 PCs to 300 PCs [ ]
3. 301 PCs to 450 PCs [ ] **4.** 451 PCs and above [ ]

8. Are PCs, Laptops, printers, etc. available to students for use? Give frequency of availability.(*Select only one option per row***)**

Type	1 Never	2 sometimes	3 Neutral	4 Frequently	5 Very Frequently
PC	[ ]	[ ]	[ ]	[ ]	[ ]
Laptop	[ ]	[ ]	[ ]	[ ]	[ ]
Scanner	[ ]	[ ]	[ ]	[ ]	[ ]
printer	[ ]	[ ]	[ ]	[ ]	[ ]

9. Give your opinion about Usage frequency of different types of software used in your institution:(*Select only one option per row***)**

Software Type	1 Never	2 sometimes	3 Neutral	4 Frequently	5 Very Frequently
In-house developed	[ ]	[ ]	[ ]	[ ]	[ ]
Open-source	[ ]	[ ]	[ ]	[ ]	[ ]
Trial version / Unlicensed	[ ]	[ ]	[ ]	[ ]	[ ]
Licensed	[ ]	[ ]	[ ]	[ ]	[ ]

10. Give your frequency of use of the following ICT services available at your institution(*Select only one option per row***)**

Sr. No.	Description	1 Never	2sometimes	3 Neutral	4 Frequently	5 Very Frequently
1	Email	[ ]	[ ]	[ ]	[ ]	[ ]
2	Social Networking	[ ]	[ ]	[ ]	[ ]	[ ]
3	Newspaper reading	[ ]	[ ]	[ ]	[ ]	[ ]
4	Job searching	[ ]	[ ]	[ ]	[ ]	[ ]
5	Listening to songs and videos	[ ]	[ ]	[ ]	[ ]	[ ]
6	Lecture and practical sessions	[ ]	[ ]	[ ]	[ ]	[ ]
7	View online lectures	[ ]	[ ]	[ ]	[ ]	[ ]
8	Research work	[ ]	[ ]	[ ]	[ ]	[ ]
9	VocationalTraining	[ ]	[ ]	[ ]	[ ]	[ ]
10	Exam work ,	[ ]	[ ]	[ ]	[ ]	[ ]
11	Beyond syllabus learning	[ ]	[ ]	[ ]	[ ]	[ ]
12	Others	[ ]	[ ]	[ ]	[ ]	[ ]

11 .State the extent to which you yourself is satisfied with the following ICT services.(*Select only one option per row***)**

Sl. No.	Service Description	1 Strongly Dissatisfied	2 Dissatisfied	3 Neutral	4 Satisfied	5 Strongly Satisfied
1	Internet services through wired network	[ ]	[ ]	[ ]	[ ]	[ ]
2	Internet services through Wi-Fi	[ ]	[ ]	[ ]	[ ]	[ ]
3	Maintenance / Technical support	[ ]	[ ]	[ ]	[ ]	[ ]
4	Administration software	[ ]	[ ]	[ ]	[ ]	[ ]
5	Academic application software	[ ]	[ ]	[ ]	[ ]	[ ]
6	ICT Security policies and Security facility	[ ]	[ ]	[ ]	[ ]	[ ]
7	Storage and Backup utilities	[ ]	[ ]	[ ]	[ ]	[ ]
8	Communication facilities (email, SMS, alert messaging, etc.)	[ ]	[ ]	[ ]	[ ]	[ ]

12. Which of the following measures you think can prove to help in improving user satisfaction regarding ICT infrastructure of your institution. (*Select only one option per row*)

Sl. No.	**Description**	**No**	**Can't say**	**Yes**
1	Training of technical support staff	[ ]	[ ]	[ ]
2	Increase in number of technical support staff	[ ]	[ ]	[ ]
3	Replace old PCs, laptops, etc.	[ ]	[ ]	[ ]
4	Provide after-hour lab facility	[ ]	[ ]	[ ]
5	Leniency in access and content control on internet usage	[ ]	[ ]	[ ]
6	Increase Internet bandwidth and making available on all PCs	[ ]	[ ]	[ ]
7	Anti-virus	[ ]	[ ]	[ ]
8	ERP and other software used for teaching-learning	[ ]	[ ]	[ ]
9.	More Frequent updating of organization's ICT Security Policy in consultation with stakeholders including staff and students	[ ]	[ ]	[ ]
10.	Any other: ______________________________	[ ]	[ ]	[ ]

13. To what extent are you satisfied with the overall ICT infrastructure security?

1 Strongly Dissatisfied	**2** Dissatisfied	**3** Neutral	**4** Satisfied	**5** Strongly Satisfied

14. To what extent are you satisfied with the overall ICT Digital assets security?

1 Strongly Dissatisfied	**2** Dissatisfied	**3** Neutral	**4** Satisfied	**5** Strongly Satisfied

15. Give your view on the following(*Select only one option per row*)

Sr. Nbr	**Description**	**Yes**	**No**
1.	Is ICT security policy displayed in labs and prominent areas in your institution?	[ ]	[ ]
2.	Have you ever been educated about your institution's ICT POLICY?	[ ]	[ ]
3.	Have you ever been educated about Cyber laws (e.g. IT Act 2000, etc.) by your institution	[ ]	[ ]
4.	Do you have restriction on what you surf on the college internet	[ ]	[ ]
5.	Are you able to install any software on your institute's PCs	[ ]	[ ]
6.	Has your data ever been destroyed by virus from the PCs or pen drives, etc. while you were accessing it on your Institute's PC	[ ]	[ ]
7.	Has your institution's Website ever been hacked?	[ ]	[ ]
8.	Have you ever given your ICT username (e.g internet, file drive) to your friends	[ ]	[ ]

16. Give your views regarding the areas which you think need to be address to improve ICT security in your organization?(*Select only one option per row*)

Sl. No.	Areas of Improvement	No	Can't say	Yes
1	User Awareness about cyber laws	[ ]	[ ]	[ ]
2	Delegation and Fixation of responsibility	[ ]	[ ]	[ ]
3	Stringent penalties	[ ]	[ ]	[ ]
4	Train users to identify ICT security risks	[ ]	[ ]	[ ]
5	Understanding and awareness of available security responses	[ ]	[ ]	[ ]
6	Identification and blocking loopholes in security	[ ]	[ ]	[ ]
7	Changes in routines, beliefs and informal norms used in the organization	[ ]	[ ]	[ ]

17. Any other Suggestions / remarks

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18. Other General Information

A.	**Name: of organization:** ____ (Optional)
B. **C.** **D.**	**Address**(Optional)**:** ____ **City:** ______________________ **Website:** _____________________________
E. **F.**	**Name of Respondent:** ____ **Designation : ____** **(* Students mention designation as student)**

ANNEXURE D - QUESTIONNAIRE FOR TECHNICAL STAFF

Questionnaire for the Technical Staff of Institutes and Universities who are imparting Higher Technical education courses. The researcher is conducting survey and recording information to carry out research which will help researcher to come up with suitable outcome for the Institutes and Universities in and around Pune District. The information collected here is only for research purpose and in no way will be used for commercial purpose.

1. **Type of respondent :** Internalstaff : [ ] Contracted staff: [ ] Visit-based staff: [ ]

2. **of Institution: (***Select only one option***)**

   (1)Government/Statutory University [ ] (2)Deemed / Private University [ ]
   (3)Autonomous College [ ] (4)Institution of National Importance [ ]
   (5)Affiliated College [ ]
   (6)If affiliated institution: Please specify University of Affiliation:___________________

3. **Types of Courses** : (6)Graduate [ ] (2)Post Graduate [ ]

4. **Approval from AICTE** : (1)Yes [ ] (2)No [ ]

5. **l Number of Students(all years):(***Select only one option)*

(1) Upto 300	[ ]	(2) More than 300 but less than 600	[ ]
(3) More than 600 but less than 900	[ ]	(4) More than 900 but less than 1200	[ ]
(5) More than 1200 but less than 1500	[ ]	(6) Above 1500	[ ]

6. **Government Support:**
   Aided [ ]
   Unaided [ ]

7. **Location** : (1) Urban [ ]
   (2) Rural [ ]

8. **Courses Conducted (AICTE Approved only):**
   (1)Engineering / Architecture [ ] (7) Management / Hotel Management/ MCA [ ] (3)Pharmacy [ ]

9. **Total Number of Staff members: (*<u>select only ONE</u>*)**

1.	Up to 50	[ ]	**2.**	More than 50 but less than 100	[ ]
3.	More than 100 but less than 150	[ ]	**4.**	More than 150 but less than 200	[ ]
5.	More than 200	[ ]			

10. **Select only one option which best describes your institution's geographical setup:***<u>(select only one)</u>*
    5) Single institute located only in one single building [ ]
    6) Group of institutions located in same campus [ ]
    7) Group of institutions spread in 2 or more campuses located in same city [ ]
    8) Group of institutions spread in 2 or more campuses located in different cities [ ]

11. **rding to which norms have you created your ICT infrastructure?(***Select only one option***)**

1.	AICTE Norms	[ ]	**2.**	DTE Norms	[ ]
3.	Government Norms	[ ]	**4.**	UGC	[ ]
5.	Affiliating University	[ ]			[ ]

12. t type of ICT implementation support did your organization go for? (*Select only one option*)

1. Large general consulting firm [ ] **2.** Independent specialist consultants [ ]
3. Vendor support [ ] **4.** Internal resources [ ]

13 l number of PCs available in your institution?(*Select only one option*)

1. Up to 150 PCs [ ] **2.** 151 PCs to 300 PCs [ ]
3. 301 PCs to 450 PCs [ ] **4.** 451 PCs and above [ ]

14. Total Number of Technical Staff members: (*select only ONE*)
1. Upto 5 [ ] 2. More than 5 but less than10 [ ]
3. More than 10 but less than 15 [ ] 4. More than 15 but less than 20 [ ]
5. More than 100 [ ] [ ]

15. Are Laptops, scanners and printers available to students and staff for use?Give frequency of availability.(*Select only one option per row*)

Type	**1** Never	**2**sometimes	**3** Can't say	**4** Frequently	**5** Very Frequently
PC					
Laptop					
Scanner					
Printer					

16. t type of PCs and Servers does your institution have?(*Select only one option*)
(1) Branded [ ] (2) Non-branded [ ] (3) Both [ ]

17. Please give your opinion about frequency of use of the software in your institution.(*Select only one option per row*)

Software Type	**1** Never	**2** sometimes	**3** Can't say	**4** Frequently	**5** Very Frequently
In-house developed					
Open-source					
Trial version / Unlicensed					
Licensed					

18. t is the speed of internet connection at your institution? (*Select only one option*)

1. No Internet Connection [ ] **2.** More than 5 Mbps [ ]
3. More than 5Mbps but less than 10 Mbps [ ] **4.** 10 Mbps but less than 15 Mbps [ ]
5. 15 Mbps and above [ ]

19. t is the type of Internet Connection used in your organization?(*Select only one option***)**

1.	No Connection	[ ]	**2.**	Broadband	[ ]
3.	Leased Line	[ ]	**4.**	ISDN	[ ]
5.	Dial-up	[ ]	**6.**	Can't say	[ ]

20. What are the purposes you are using institution's ICT for?
(Select only one option per row)

Sl. No.	**Description**	**1** Never	**2**sometimes	**3** Can't say	**4** Frequently	**5** Very Frequently
1	Email					
2	Social Networking					
3	Newspaper reading					
4	Job searching					
5	Listening to songs and videos					
6	Lecture preparation					
7	View online lectures					
8	Research work					
9	Administrative work					
10	Exam work ,					
11	Lecture delivery Practical sessions					
12	Others					

21. Are you connected to ERNET network?Yes [ ] No [ ] Can't say [ ]

22. State the extent to which you yourself is satisfied with the following ICT services.(*Select only one option per row***)**

Sl. No.	**Service Description**	**1 Strongly Dissatisfied**	**2 Dissatisfied**	**3 Can't say**	**4 Satisfied**	**5 Strongly Satisfied**
1	Internet services through wired network	[ ]	[ ]	[ ]	[ ]	[ ]
2	Internet services through Wi-Fi	[ ]	[ ]	[ ]	[ ]	[ ]
3	Maintenance / Technical support	[ ]	[ ]	[ ]	[ ]	[ ]
4	Administration software	[ ]	[ ]	[ ]	[ ]	[ ]
5	Academic application software	[ ]	[ ]	[ ]	[ ]	[ ]
6	ICT Security policies and Security facility	[ ]	[ ]	[ ]	[ ]	[ ]
7	Storage and Backup utilities	[ ]	[ ]	[ ]	[ ]	[ ]
8	Communication facilities (email, SMS, alert messaging, etc.)	[ ]	[ ]	[ ]	[ ]	[ ]

23. Which of the following measures you think can or have proved to help in improving user satisfaction. (*Select only one option per row***)**

Sl. No.	Description	No	Can't say	Yes
1	Training of technical support staff	[ ]	[ ]	[ ]
2	Increase in number of technical support staff	[ ]	[ ]	[ ]
3	Replace old PCs, laptops, etc.	[ ]	[ ]	[ ]
4	Provide after-hour lab facility	[ ]	[ ]	[ ]
5	Leniency in access and content control on internet usage	[ ]	[ ]	[ ]
6	Increase Internet bandwidth and making available on all PCs	[ ]	[ ]	[ ]
7	Anti-virus	[ ]	[ ]	[ ]
8	ERP and other software used for teaching-learning	[ ]	[ ]	[ ]
9.	More Frequent updating of organization's ICT Security Policy in consultation with stakeholders including staff and students	[ ]	[ ]	[ ]
10.	Any other: ________________________________	[ ]	[ ]	[ ]

24. To what extent are you satisfied with the overall ICT infrastructure security?(*Select only one option per row***)**

1 Strongly Dissatisfied	**2** Dissatisfied	**3** Can't say	**4** Satisfied	**5** Strongly Satisfied

25. To what extent are you satisfied with the overall ICT Digital assets security?(*Select only one option per row***)**

1 Strongly Dissatisfied	**2** Dissatisfied	**3** Can't say	**4** Satisfied	**5** Strongly Satisfied

26. Rate on the scale of 1 to 5 (1-lowest and 5-highest) the level of ICT security attacks your organization has received

Sl. No.	Level of Attack	Rate
1	**Low intensity attacks**(low operational, data and financial loss)	☐
2	**Mild intensity attacks**(mild operational, data and financial loss)	☐
3	**High intensity attacks**(high operational, data and financial loss)	☐

27. What is your role in policy making?

2. No role [ ] 2. Consultative [ ] 3. Lone Creator [ ] 4. Final decision maker [ ]

28. Do you have an ICT up-gradation policy in your organization? Yes **[ ]** Cant' say [ ]No [ ]

29. On how many servers do you have licensed antivirus?(1)None[ ] (2) Few [ ] (3)All[ ]

30. On how many PCs do you have licensed antivirus?None[ ] (2) Few [ ] (3) All[ ]

31. As per your experience in the organization, tell us the extent each of the following factors play a major role in committing of ICT security attacks in your organization.(*Select only one option per row***)**

Sl. No.	Description of Factors	1 Very low Effect	2 Low effect	3 Can't say	4 High Effect	5 Very High Effect
1.	Carelessness of users	[ ]	[ ]	[ ]	[ ]	[ ]
2.	Lack of equipment / technology / software in the institution to avoid ICT attacks	[ ]	[ ]	[ ]	[ ]	[ ]
3.	Lack of training to technical staff	[ ]	[ ]	[ ]	[ ]	[ ]
4.	Lack of Technical staff	[ ]	[ ]	[ ]	[ ]	[ ]
5.	Lack of Physical security (unauthorized access to labs/ ICT facilities leading to thefts, etc.)	[ ]	[ ]	[ ]	[ ]	[ ]
6.	Lack of User awareness about Risks, cyber laws, etc.	[ ]	[ ]	[ ]	[ ]	[ ]
7.	Lack of fixation of responsibility and liabilities on users	[ ]	[ ]	[ ]	[ ]	[ ]
8.	Lack of management support	[ ]	[ ]	[ ]	[ ]	[ ]
9.	Lack of concrete ICT security policy	[ ]	[ ]	[ ]	[ ]	[ ]
10.	Lack of ICT Purchase and Up-gradation policy	[ ]	[ ]	[ ]	[ ]	[ ]
11.	Low financial Budget for ICT infrastructure	[ ]	[ ]	[ ]	[ ]	[ ]
12.	User inquisitiveness to try new ways of hacking/ bypassing security/ install free software	[ ]	[ ]	[ ]	[ ]	[ ]
13.	Lack of hardware / data ,etc. disposal policy	[ ]	[ ]	[ ]	[ ]	[ ]
14.	Lack of Data Governance (Management/storage/dispersion) policy	[ ]	[ ]	[ ]	[ ]	[ ]
15.	Pirated Software	[ ]	[ ]	[ ]	[ ]	[ ]
16.	Lack of Content management	[ ]	[ ]	[ ]	[ ]	[ ]
17.	Budget	[ ]	[ ]	[ ]	[ ]	[ ]
18.	Other reasons	[ ]	[ ]	[ ]	[ ]	[ ]

32. Rate the extentof success of the following factors in being able to reduce / prevent ICT security lapse or attack: (1-lowest and 5-highest)

Sl. No.	Description of Factors	Rate (1 to 5)
1	Institution's ICT security policy is able to secure ICT infrastructure and data assets	
2	Technical staff able to manage ICT infrastructure and its security	
3	Security audit able to find gaps in ICT security	
4	Physical security of campus / building like CCTV, biometric access controls	
5	Educating of staff and students about ICT laws and Best Practices	
6	Antivirus, firewall, auto-updates, etc.	

33. Give your views regarding the areas which you think need to be address to improve ICT security in your organization? (*Select only one option per row***)**

Sl. No.	Areas of Improvement	No	Can't say	Yes
1	User Awareness about cyber laws	[ ]	[ ]	[ ]
2	Delegation and Fixation of responsibility	[ ]	[ ]	[ ]
3	Stringent penalties	[ ]	[ ]	[ ]
4	Train users to identify ICT security risks	[ ]	[ ]	[ ]
5	Understanding and awareness of available security responses	[ ]	[ ]	[ ]
6	Identification and blocking loopholes in security	[ ]	[ ]	[ ]
7	Changes in routines, beliefs and informal norms used in the organization	[ ]	[ ]	[ ]

34. What Percentage of Annual Budget is set aside for ICT? (*Select only ONE option*)

1.	Less than 5 % of annual budget	[ ]	2.	More than 5% but less than 10 % of annual budget	[ ]
3.	More than 10% but less than 15% of annual budget	[ ]	4.	More than 15% but less than 20% of annual budget	[ ]
5.	20% and above of annual budget	[ ]	6.	Can't Say	[ ]

35. What Percentage of Annual Budget set aside for New purchases / Up-gradation of ICT is actually used? (*Select only one option*)

1.	Less than 20 % but less than sanctioned ICT budget	[ ]	2.	More than 20% but less than 40 % of sanctioned ICT budget	[ ]
3.	More than 40% but less than 60% of sanctioned ICT budget	[ ]	4.	More than 60% but less than 80% of sanctioned ICT budget	[ ]
5.	80% and above of sanctioned ICT budget	[ ]	6.	Can't Say	[ ]

36. Investment in ICT infrastructure is every penny worth spent. Please give your view on this?(*Select only one option per row*)

1 Strongly disagree	**2** Disagree	**3** Can't say	**4** Agree	**5** Strongly Agree
☐	☐	☐	☐	☐

37. Kindly state the extent of benefits or maximum Return of Investments on ICT for the following areas?(*Select only one option per row*)

Sl. No.	**Description**	**1** Very Low	**2** Low	**3** Can't say (Can't Say)	**4** High	**5** Very High
1	Examination process	[ ]	[ ]	[ ]	[ ]	[ ]
2	Communication	[ ]	[ ]	[ ]	[ ]	[ ]
3	Manpower (Teaching, Non-teaching, etc.) staff	[ ]	[ ]	[ ]	[ ]	[ ]
4	Research	[ ]	[ ]	[ ]	[ ]	[ ]
5	Administration	[ ]	[ ]	[ ]	[ ]	[ ]
6	Decision making	[ ]	[ ]	[ ]	[ ]	[ ]
7	Stationary (e.g. paperless office)	[ ]	[ ]	[ ]	[ ]	[ ]
8	Information storage and access	[ ]	[ ]	[ ]	[ ]	[ ]
9	Automation and integration	[ ]	[ ]	[ ]	[ ]	[ ]
10	Others	[ ]	[ ]	[ ]	[ ]	[ ]

38. State extent you agree with benefits provided by implementation of ICT in your higher technical education institution. (*Select only one option per row*)

Sl. No.	Description of benefit	1 Strongly disagree	2 Disagree	3 Can't say (Neutral)	4 Agree	5 Strongly Agree
Strategic benefits						
1	Maximize resource utilization including learning resources					
2	Standardize processes					
3	Simplification and decentralization decision making					
4	Reduced need of direct attention					
5	Investment decisions					
6	Result delivery					
7	Enhanced public profile of institution **(Brand Building)**					
8	Expand expertise base					
9	knowledge Sharing					
10	Efficiency and accuracy in delivery					
11	Identification of areas which are consuming time and money					
12	Attract more students and expert faculty members					
13	Increase variety and depth in research and innovation					
14	Understand strategic needs					
15	Understand changing environment and requirements					
16	Better co-ordination of activities					
17	Effective communication between staff, students and other stakeholders					
18	Staff Skill development					
19	Strategic partnering with external institutions					
Monetary Benefits						
20	Profit margin maximization and wealth creation					
21	Reduced labour costs					
22	Reduced administrative costs					
23	Reduction in teaching-learning costs					
24	Reduced payback period					
25	Increase in admissions					
26	Facility rentals for corporate training and online exams					

39. Do you have Wi-Fi in your organization?

a. Yes b. No

40. Do you keep logs of internet usage?

a. Yes b. No

41. Are regular ICT security audits conducted at your organization?

a. Yes b. No

42. Does your have a drafted ICT Security policy?

a. Yes b. No

43. Is the ICT Security Policy displayed in labs and other prominent places in the college / institution?

a. Yes   b. No

44. Any Suggestions / Remarks

Other General Information

A.	**Name: of organization:** ____ (Optional)
B.	**Address**(Optional)**:** ____ **City:** ____________________ **Website:** __________________________
C. **D.**	**Name of Respondent:** ____ **Designation :** ____

ANNEXURE E - IMPORTANT DEFINITIONS

TECHNICAL EDUCATION:

The academic preparation of students for jobs relating to applied science and modern technology. Its primary aim is to prepare students for occupations coming under the category of skilled crafts.

In Indian context, Under The AICTE Act 1987, "Technical Education means programmes of education, research and training in engineering technology, architecture, town planning, management, pharmacy and applied arts and crafts and such other programme or areas as the central government may declare in consultation with AICTE".

(Source: The All India Council for Technical Education Act 1987, http://www.aicte-india.org/downloads/aicteact.pdf, page 2)

HIGHER TECHNICAL EDUCATION

A university level education with generally 3 or 4 years duration of courses providing a Diploma or Degree in technical education at Graduate or Post-Graduate Level.

PROFESSIONAL COURSE:

A professional course is a college or university level course which is designed to train people who are either already working in, or wish to get employed in corporate, government or technology fields. It leads to a professional qualification like an Engineer, Architect, Manager, etc. these aid people with various professional skills and competencies which can help them in the earning of their livelihood and running the life in the reasonable style.

UNIVERSITY:

As defined in clause (f) of University Grants Commission Act. 1956, "a university is an institution deemed to be a university u/s 3 of the UGC act".

(Source: The All India Council for Technical Education Act 1987, http://www.aicte-india.org/downloads/aicteact.pdf, page 2)

TECHNICAL INSTITUTION

An institution, not being a university, which offers courses or programs of technical education, and shall include such other institutions as the Central government may, in consultation with AICTE, by notification in Official gazette, declare as technical institution.

(Source: The All India Council for Technical Education Act 1987, http://www.aicte-india.org/downloads/aicteact.pdf, page 2)

Synopsis of

"A critical study of management and security of (ict) information communication technology in higher technical institutes in pune region"

1. INTRODUCTION

Information and Communication Technology (ICT) is a facilitator of an enterprise's business processes and manages the resources of an organization. ICT has played a big role in Higher Technical Education as it provides platform to help in explanation of complex processes and phenomenon. It also provides access to vast knowledge resources. Online Library, free platforms like YouTube, Journal repositories, Blogging and Video lectures can help students get to scholarly literature of national and International sources very easily. Globally, reputed institutions have adopted ICT as a tool for betterment of academic fraternity.

The study of ICT infrastructure facilities and ICT enabled services provided in higher technical education institutions is a great learning paradigm to understand and enhance the readiness of such institutions for the digital revolution in India especially in academic fraternity.

ICT not only includes the hardware, software and network equipment. WHEN, WHERE, and WHICH ICT services will be provided in the institution and WHO has the permission to access them all depends on Institute's Management's decisions.

As a general observation it has been seen that ICT infrastructure and services including its security is not as per expectations of the end-users as well as statutory requirements in higher educational institutions. There is a need to address the gaps in ICT implementation, highlight problems in its security, recognize satisfaction patterns of its end-users, leading to identification of the problematic areas, implement remedial measures through change in management policies and strategies.

These things need to be addressed before planning ICT implementation in schools and colleges.

2. STATEMENT OF PROBLEM

As a general observation, most of the technical education institutions are facing major problem of ICT infrastructure management in the institution with regards to policy, security and user perspective in term of management. Keeping this in mind the researcher has framed and stated the problem as:

"To study the I.C.T. infrastructure facilities and services as provided by Institutions imparting Higher Technical Education with respect to its Management including security aspects. Also, to understand the user satisfaction pattern and problems associated with these facilities with an intent to suggest remedial measures in order to avoid loopholes so as to obtain envisaged results".

The research is related to the study of ICT facilities being provided along with its usage patterns in the Institutions imparting Higher Technical Education. It studies whether they are as per norms laid down by statutory regulatory body for higher technical education i.e. AICTE. It also studies the security issues attached to it. Further, it goes into understanding the user satisfaction attained from ICT facilities. It, also, strives to understand the benefits accumulated from ICT facilities in the Institutions imparting Higher Technical Education. The geographic region is limited to Pune region.

It takes into consideration only those colleges or institutions which, in particular, are approved by AICTE for running that particular course. Only Under-Graduate and Post Graduate degree courses have been considered.

3. SIGNIFICANCE & IMPORTANCE OF THE STUDY

The study of ICT infrastructure facilities and ICT enabled services provided in higher technical education institutions is a great learning paradigm to understand and enhance the readiness of such institutions for the digital revolution in India especially in academic fraternity. The findings of the study will rebound to the society and students, in particular, considering that ICT has been identified as a major tool for the purpose of knowledge dispersion. The goals of this study will help bring the ICT setup and facilities to a stage where it will help institutions develop teaching-learning skills that will help students in acquisition of knowledge for gaining employment and giving their full participation in country's development.

By understanding the needs of the students, including other stakeholders, and benefits of quality ICT setup, these teaching staff and students be assured of a competitive edge in the world market.

The objectives of the study are designed to help government as well as Management of Institutions identify the ICT facilities that are in place and find the areas which are lacking behind, as per norms prescribed by AICTE and the expectations of the stakeholders, so that all stake holders get world class ICT facilities in their institutions and the data is also in safe hands.

As Pune is not only an academic hub but also an industrial hub on the world map so the results of this study can even be used as an example to create a bigger picture of the scenario at the national level.

If suggestions are implemented the biggest beneficiaries of the study will be students who, through the use of ICT facilities in the institution, will be able to improve academic competence, develop employability skills, gain knowledge from latest research papers and books available online.

4. REVIEW OF LITERATURE

To identify the gap, the researcher has made extensive review of literature. Researcher found certain relevant research studies and papers pertaining various aspects of implementation and use of ICT infrastructure.

The researcher has identified the parameters related to ICT implementation, User satisfaction, ICT security breaches, etc. Researcher has defined the following parameters, which are further used for designing questionnaires.

Table 1: Parameters of ICT Infrastructure

Norms followed for creating ICT infrastructure.	ICT implementation support source	Total number of Support Staff	Type of PCs and Servers
Internet Speed (Bandwidth) subscription.	Intensity Level of ICT attacks encountered.	Role in ICT Security Policy framing.	Presence of ICT up-gradation policy.
No. of Licensed Antivirus software available of PCs and Servers	Factors influencing increase in ICT security attacks / lapses	Factors which help reduce / prevent ICT security lapse or attack	Purpose of using institution’s ICT infrastructure

Percentage of Annual Budget is set aside for ICT and Actual expenditure Percentage made on New purchases / Up-gradation of ICT	Success factors influencing reduction / prevention of ICT security lapse.	Areas providing benefits and maximum Return on Investments on ICT.	Availability of Wi-Fi
Audit frequency	Maintenance of Internet usage logs	Drafted ICT policy in the institution and its display in the institution.	

5. RESEARCH METHODOLOGY

A. OBJECTIVE OF THE STUDY

The researcher has set five Objectives:

1. To study the ICT infrastructure facilities and ICT enabled services provided by institutions.
2. To study user satisfaction with regards to ICT facilities and services provided by institutions.
3. To identify gaps in Management of ICT facilities and services with special emphasis on ICT security and identify solutions from management perspective in order to receive envisaged results.
4. To study the benefits of use of ICT facilities and services in institutions including their impact on day to day functioning of the institutions.
5. To suggest a theoretical model to improve efficiency of ICT in Institutions imparting Higher Technical Education.

Note: The 5th objective has been taken as part of the suggestions.

B. HYPOTHESIS OF THE STUDY

HYPOTHESIS 1:

H_0: There is No significant difference in availability of basic ICT facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.

H_1: There is a significant difference in availability of basic ICT facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.

HYPOTHESIS 2:
H_0: Institution's ICT security policy has NOT been able to secure ICT infrastructure of the institution.
H_1: Institution's ICT security policy has been able to secure ICT infrastructure.

HYPOTHESIS 3:
H_0: ICT security policy document created by the institute's Management is NOT displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.
H_1: ICT security policy document created by the institute's Management is displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.

C. RESEARCH DESIGN

The **Descriptive Research Methodology** has been followed in this research study.

THE SECONDARY DATA

Researcher have obtained secondary data from Journals, books, white papers, newspaper articles, thesis, research papers, websites, government reports, published and unpublished records and articles.

THE PRIMARY DATA

The survey method has been used to collect Primary data. Taking the help of **Stratified sampling,** institution which are imparting Higher Technical Education courses recognized by AICTE, New Delhi have been **Stratified** into 3 strata: **Management Strata**, **Engineering Strata, and Pharmacy Strata.**

Geographic Area of study: Pune region

Type of Institutions covered: Higher Technical Education Institutes conducting AICTE approved professional courses like MBA, MCA, BE, ME, B.Arch, M.Arch, B.Pharma, M.Pharma. No Diploma courses.

Criteria for selection for Institutes

- Must be running an AICTE approved Higher Technical Education course

- Must have a minimum of 5 years with academic year 2014-15 as the base year.

Primary data has been collected from respondents categorized into 4 types **Head of Institute, ICT Support Staff Members, Full-time Students (Learners), Full-time Teaching Staff members** of the institutes as defined.

POPULATION & SAMPLE DETAILS

For the academic year 2014-15, as per the AICTE dashboard available at http://www.aicte-india.org/dashboard/pages/dashboardaicte.php, in the state of Maharashtra there are 60,820 full-time Teaching staff, 2,84,420 Full-time Students (UG and PG AICTE approved courses), and 1320 institutions running AICTE approved courses which forms the universe for the study.

(A) Population details of Institutions imparting Higher Technical Education

Engineering Colleges- 48, Management Colleges-94, Pharmacy colleges-21

(B) Population and Sample details of Sample (Respondents)

Table 2: Respondent Population and Sample

	ICT Technical Staff	**Full-Time Teaching Staff**	**Full-Time Students**	**Head of Institutes**
Population description	No. of ICT Technical support staff	No. of Teaching Staff from Institutes working full-time	No. of enrolled students from different Institutes (only full-time)	Director/ Principal/ HODs/ Institute owners
Population size	1 per institute (163 Nos.)	Total number of full-time teaching staff in ratio of total enrolled students. (9634)	Total no. of full time enrolled (sanctioned) students in AICTE approved courses in all years (144529)	1 per institute (163 Nos.)

Sample size required as per Krejcie and Morgan Chart (Confidence= 95% and Degree of Accuracy/Margin of Error being at 0.05)	115	369	384	115
Actual no. of VALID responses	111	332	435	38
%age of Total Population	68.10%	3.45%	0.03%	23.31%
Sampling Method	Stratified Sampling Method			

Instruments for Data collection

Researcher has used Structured Questionnaires, interviews, and observations for collecting primary data from respondents.

Tools for Analysis of Data

The researcher has used Microsoft Excel, and SPSS for the purpose of analysis of data and testing of hypothesis. For testing of hypothesis various tests like z-test and t-test were used at appropriate places.

Reliability testing

Researcher has carried out reliability testing in order to ensure that the respondents understand the questions asked and that the questions asked are able to provide data which are needed to attain the objectives of the study. Considering the responses obtained, relevant changes were made in the questionnaire for final data collection.

6. DATA ANALYSIS, OBSERVATIONS & FINDINGS

Data analysis was carried under following 4 categories:

a. ICT infrastructure facilities and ICT enabled services provided by institutions.
b. User satisfaction with regards to ICT facilities and services provided by institutions.
c. Gap identification in management of ICT facilities and services with special emphasis on ICT security and identification of solutions from management perspective.
d. Benefits of use of ICT facilities and services in institutions including their impact on day-to-day functioning of the institution.

Based on the analysis carried out on the data that was collected from respondents, the researcher has come up with the following observations and findings:

6.1 The ICT infrastructure facilities and ICT enabled services provided by institutions.

- It has been observed that Student-PC ratio has been adequately met in case of all institution types except Management institutions having students in the range of 300 to 600 students and beyond.
- It has been found that *Vendor Support* (87.92%) is most commonly preferred Source for ICT implementation whereas *Large general consulting firm* (22.82%) is least preferred.
- It has been found that *AICTE Norms* (74.49%) is most frequently used followed by *Affiliating University Norms* (49.44%) for creating ICT infrastructure.
- It has been found that *Branded PCs and Servers* (67%) are most commonly available for use followed by a *mix of Both Branded and Non-Branded PCs and Servers* (32%) which is quite considerable.
- It has been found that *In-House developed software* is least frequently used in institutions.
- It has been observed that Broadband (51.4%) is most commonly used internet connection type followed by Leased-line (48.6%).
- It has been observed that Technical and Teaching Staff use ICT infrastructure mainly for *Research Work, Email* and *Lecture Preparation. Job Searching* and *Listening to Songs and Videos* are least used. Students use it for *Email*, *Lecture & practical sessions*, & *Social Networking*. Least used purposes are *View Online Lectures* and *Vocational Training*.
- It has been observed that 86.49% respondent's institutions have Wi-Fi network installed while in 13.51% cases it is not installed.

6.2 User satisfaction with regards to ICT facilities and services provided by institutions.

- The top 3 services in terms of user satisfaction are *Communication facilities (email, SMS, alert messaging, etc.), Internet services through wired network,* and *Academic application software*. Least satisfying is *Storage and Backup utilities*.

- The Top 3 Measure to improve user satisfaction are *Antivirus*(91.80%), *Training of technical support staff*(79.04%) and *Increase Internet bandwidth and making available on all PCs*(79.04%). *More Frequent updating of organization's ICT Security Policy in consultation with stakeholders including staff and students* (55.47%) is the least required improvement area.

6.3 Gaps identification in Management of ICT facilities and services with special emphasis on ICT security and identify solutions form management perspective in order to receive envisaged results.

- Technical Staff and Head of Institute are satisfied with *overall ICT Digital assets security* whereas Students who constitute the majority of end-users are actually dissatisfied.
- It has been found that *Low intensity attacks* have Moderately Low rate of occurrence on overall basis. *Mild intensity attacks* have Moderately Low rate of occurrence. *High intensity attacks* have Moderately Low rate of occurrence on overall basis.
- *Head of Institute* are mainly *Final Decision Maker* (76.3%) while Technical Staff mainly have *Consultative* (82.9%) role w.r.t. Role played in creating ICT policy.
- It has been observed that overall only 23.28% respondent's institutions have a *formal ICT Up-gradation Policy* where as 37.21% don't have it.
- 56.38% respondent's institutions have Antivirus installed on *All Servers* whereas 40.94% have it installed on *Few Servers* which is an area of concern.
- 34.23% respondent's institutions have antivirus installed on *All PCs* whereas 65.77% have it is installed on *Few PCs* which is an area of concern.
- The major role playing factors in committing of ICT security attacks are *Lack of Technical staff, Carelessness of users,* and *Lack of equipment / technology / software in the institution to avoid ICT attacks.* Least role playing factors are *Lack of hardware / data, etc. disposal policy, Lack of Content management, Lack of Data Governance (Management/storage/dispersion) policy,* and *Lack of fixation of responsibility and liabilities on users*.
- Factors playing high role in reducing/preventing ICT security attacks are *Technical staff able to manage ICT infrastructure and its security, Antivirus, firewall, auto-updates, etc.*, and *Educating of staff and students about ICT laws and Best Practices*.

- The major areas that need to be addressed to improve ICT security are *User Awareness about cyber laws*, *Train users to identify ICT security risks*, and *Identification and blocking loopholes in security*.
- 57.01% respondent's institutions do not *display ICT security policy in labs and prominent areas of the institution*.
- In majority (62.30%) of cases, the respondent's institutions do not *educate their Users about your institution's ICT Policy*.

6.4 The benefits of use of ICT facilities and services in institutions including their impact on day to day functioning of the institutions.

- Institutions are allotting, on an average, only 18.13*% of their total annual budget for ICT*.
- Institutions, on an average, are actually spending 53.14*% of their total Annual Budget set aside for New Purchases / Up-gradation of ICT, etc*.
- Area which have shown to attain maximum Return on Investments using ICT is *Communication* and *Research*. *Stationary e.g. paperless office* has provided least ROI.
- Highest benefits from ICT are in the areas of *maximum benefits* in the areas of *Knowledge Sharing*, *Effective communication between staff, students and other stakeholders*, and *Maximize resource utilization including learning resources*. *Facility rentals for corporate training and online exams*, *Reduced need of direct attention, Reduced labour costs* have not been able to be very beneficial and have landed at the bottom of the list.

7. HYPOTHESIS TESTING

Table 3: Hypothesis testing

Hypotheses of the Study	Applied Test	Level of Significance	Result
<u>**Hypothesis 1**</u> **H_0:** There is No significant difference in availability of basic ICT facilities for students in	Z-test (Z value 0.288235294)	**5%**	**The calculated value for P (two-tail) is 0.773166634.** **As value of P is > 0.05.**

Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas. **H_1:** There is a significant difference in availability of basic ICT facilities for students in Higher Technical Educational Institutions located in Pune's Urban areas and Rural areas.			**Null Hypothesis is ACCEPTED**
<u>Hypothesis 2</u> **H_0:** Institution's ICT security policy has NOT been able to secure ICT infrastructure of the institution. **H_1:** Institution's ICT security policy has been able to secure ICT infrastructure.	One sample t-test	**5%**	**The calculated value for P (two-tail) is 0.583.** **As value of P is > 0.05.** **Null Hypothesis is ACCEPTED**
<u>Hypothesis 3:</u> **H_0:** ICT security policy document created by the institute's Management is NOT displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune. **H_1:** ICT security policy document created by the institute's Management is displayed in labs and prominent areas of the Higher Technical Educational Institutions in Pune.	One sample t-test	**5%**	**The calculated value for P (two-tail) is .000** **As value of P is < 0.05.** **Null Hypothesis is REJECTED**

8. CONCLUSIONS

After going through the data and analyzing and interpreting it, the researcher has come up with the following conclusions:

- There is a deficiency in PC-Student ratio in mid-sized Management colleges. This means some institutions are somehow by-passing AICTE Norms.
- Unlike their industry counter-parts, higher education institutions don't use external Experts and Consultants. Continuous digitization of academic sector is taking place and not taking expert help is a cause of concern.
- PCs are available to all users easily. Printers are available to Staff members but not students. Users also don't get Laptops and Scanners. Therefore, we conclude that basic ICT facilities, equipment and tools are only available in part to the users.
- Very few institutions are using *Non-Branded PCs and Servers* alone (less than 5%). Majority institutions are using Only *Branded PCs and Servers* are obviously good in quality, trust worthy, last long and their performance is also much better than Non-Branded ones. The data is also safe. Considerable number of institutions are using a mix of *Branded and un-branded PCs and Servers.* If ratio of Non-Branded is higher in this mix, then it is a matter of concern.
- Problem persists with Trial-Version software which are also used in abundance and attract security and licensing problems. In-house Developed software are not very prevalently used which depicts that institutions which are running Technical courses in the field of computers, are not utilizing the skills of their staff and students to practically develop software which could give a good practical exposure to them.
- All institutions have internet subscription which is as per the norms setup by AICTE.
- Most common internet connection type in use is Broadband and Leased-line which provide good internet speed.
- Teaching Staff is inclined towards usage of ICT infrastructure for academic purpose whereas Student's usage pattern depicts that students are more inclined towards entertainment and socializing and that academics is their second preference. It is evident that there is a sharp difference between the usage patterns of Students and teaching staff.

- Wi-Fi network is generally available in majority of Higher Technical Education institutions but not all institutions allow students access to it.
- Highest user satisfaction is towards ICT services like *Communication, Internet through wired Network, maintenance and Support*, and *Academic Software* even though there is difference in perception of the 3 respondent types.
- **Storage and Backup facility is either not available at all or is not available to all users.**
- *Internet through Wi-Fi* also has lower satisfaction among users. This means that Wi-Fi even though it is available in majority of institutions but then **Wi-Fi is either available for use of select few or there are connectivity/ low bandwidth issues**.
- Most recommended ways to improve User Satisfaction are *Antivirus*, and *Increase in number of technical support staff* which feature at the top.
- Other ways for improvement as prescribed by the respondents include *24*7 printing facility, printing facility in hostels, on-line academic document ordering and verification system, centralized ICT technical desk helpline, college providing copy of academic software to use at home*, etc.
- Majority of respondents are found to be satisfied with overall ICT infrastructure security
- Students who constitute majority of end-users are actually dissatisfied with Overall digital asset security.
- As of now Low Intensity attacks are more prevalent than mild and high intensity ones. High Intensity attacks are common in developed countries. But as they will be digitized High Intensity attacks may well occur there also.
- Head of Institute's not taking advice of Technical Staff for creating ICT policy can be treated as ICT security gap as Head of Institute are not technical experts in the area of ICT security.
- Lack of ICT Up-gradation policy in considerable number of institutions has put institution's data in under high security threat and data loss risks. Institutions are not providing quality ICT facilities to their students who pay high amount of fee leading to low level of satisfaction among students.
- AICTE in its approval book doesn't make it mandatory to have licensed antivirus installed on all machines. Taking advantage of this, High number of institutions have *Antivirus Installed on few Servers* and *on Few PCs.*

- There is high risk of data stored on Servers being destroyed by virus, etc. due to lack of antivirus. Server based vital network services may also be disrupted. Student's data loss cases also show that lack of antivirus on PCs is essential.
- *Lack of technical staff* and *carelessness of users* has been found to be the biggest reasons due to which ICT security attacks take place. *Use of Pirated Software* is another factor to look for.
- Respondents feel that it is the *Technical staff able to manage ICT infrastructure and its security* and *Antivirus, firewall, auto-updates, etc.* which have been able to control ICT security attacks.
- Respondents feel that *Security audit able to find gaps in ICT security* has failed to deliver its objective.
- Respondents feel that *User Awareness about cyber laws* is overall best solution for improvement in ICT security. *Stringent Penalties*, which has highly demanded by Technical staff is not found to be acceptable by all other respondents.
- Considerable number of institutions have not *displayed their ICT security policy* in labs and prominent areas in the institution so users are not aware about terms and conditions of use of ICT infrastructure
- Majority institutions have no restrictions on installation of software on PCs by users which makes us conclude that this is the gap through which pirated and trial version software make their way into institution's network.
- Majority of students have faced situations where their data was destroyed by virus from the PCs or pen drives, etc. while they were accessing it on your Institute's PC. This proves that **Antivirus is not installed or is not regularly updated on PCs.**
- Majority of students have shared their ICT username (e.g. internet, file drive) with their friends.
- Considerable number of institutions do educate students about Cyber laws (e.g. IT Act 2000, etc.).
- Considerable number of institutions have surfing and downloading restrictions on internet which to an extent have prevented in reducing copyright violations and improved ICT security.
- Very few institutions in Pune have had their Website was hacked.
- An average of 18.13% of Annual budget dedicated for ICT looks quite small when compared to Recurring costs.

- *Non-recurring and Recurring expenditures* on ICT are not met which may lead to problems.
- *Communication* and *Research* have shown high rate of returns from investment in ICT.
- **Paper based Exams and Record-keeping are still preferred to digital one.** This expenditure of time and money is worth cutting.
- *Knowledge Sharing, Effective communication between staff, students and other stakeholders, Maximize resource utilization including learning resources, Standardize processes, Increase in admissions* have come in Top 5 services giving high ROI.

Looking at the conclusions, we can, thus, conclude that appropriate number of factors have been studied for all the objectives and so the study of this objective has been successfully completed.

9. SUGGESTIONS

General suggestions:

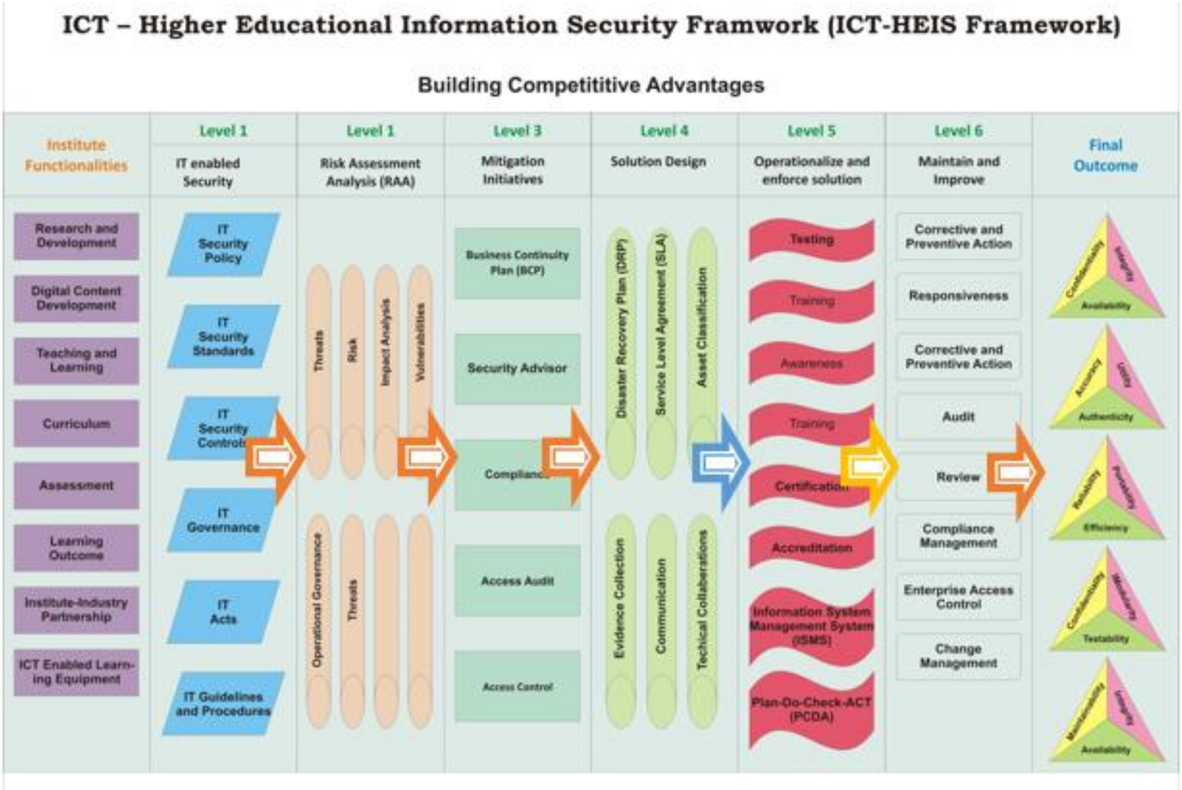
- To fight deficiency, Government can also subsidize the purchase of PCs for educational institutes.
- Norms should be specified at only UGC level. This will bring uniformity. Differentiation in norms can be made for different types of institutions / courses.
- Yearly Physical audit by 3^{rd} part instead of submission of compliance report can reduce chances of institutions flaunting prescribed norms.
- Network printers with printing quota for each user (per semester or year) will keep control on wastage for which a special software to manage printing can be installed.
- AICTE should include scanners as part of basic infrastructure and specify their quantity.
- Laptop availability can be made a part of Library.
- Management should enforce full restriction on use of pen-drives and trial version software and mention same in ICT security policy of the institute.
- Software manufacturers like Microsoft can give special limited period software license to students free or at subsidized prices through the institutions itself.
- Education regulatory bodies can mandate centralized Data Storage facilities under Data Center.

- Education regulatory bodies should make I.C.T. Usage and Security Policies mandatory and to be displayed in prominent places like they do for anti- ragging policy, etc.
- 6 monthly Audit to be mandatory for all institutions.
- Statutory educational regulatory authorities must make Antivirus compulsory for 100% PCs and Servers.
- Statutory educational regulatory authorities must make ICT upgradation policy compulsory.
- Statutory educational regulatory authorities must also prescribe minimum hardware requirements in terms of R.A.M., Hard disk, Processor, etc.
- Universities should create and maintain high capacity servers and allow access to the affiliated institute students for specialized academic learning.
- ICT security policy must include hardware disposal procedures for scrapping old PCs and servers which might contain hard disks with vital data.
- A data governance policy needs to be created and should be implemented through ERP software.
- ICT policy must also mention the penalties for not following the provisions mentioned in it.
- Institutes should conduct multiple choice questions pattern of examinations system using software. This will save teachers time w.r.t. answer books evaluation and will save paper stationary too.
- To improve return on investments in information Storage and access, we need to improve ERP software and storage & backup utilities. Doing this will also help the management in taking decisions effectively.
- Statutory education regulatory body should specify the number of ICT technical staff and their minimum qualification in ration of PCs required by the institution.
- Statutory education regulatory body must make it compulsory for institutions to have only branded computers.
- Statutory education bodies need to mandate the presence of Wi-Fi network both in institution and hostels and fix the internet bandwidth requirement on Wi-Fi network.
- Current students can also be appointed on limited hours basis to work as support staff in labs like what is practiced in developed nations under EARN-AND-LEARN initiative.

- Institutes must make it mandatory for technical staff to go for regular upgrade of their skills like it is practiced in industries.
- Government should subsidize the Internet bandwidth rates for educational institutions.
- Internet bandwidth monthly quota of upload and download can be fixed per user basis to will decrease wastage of internet data by users.
- To avoid the increase in frequency of High intensity ICT security attacks in future, relevant security tools and equipment need to be used from now itself along with user awareness programs. Stringent penalties can be levied on both Staff and students if negligence is found from their side.
- Unified Threat Management devise with usage record logging facility must be made compulsory in each institute.
- Statutory educational regulatory bodies can set ICT budget in ratio of student enrolment. To make sure that this amount is actually spent, a compliance report submission may be made compulsory.

Proposed and designed theoretical model to improve efficiency of ICT in Institutions imparting Higher Technical Education: ICT-Higher Educational Information Security (ICT-HEIS) Framework

The researcher has put forward a theoretical framework designed with the objectives to providing Data governance, manage security issues, and aims at maintaining business continuity and build competitive advantage in the Higher Technical Education Institutions.



This frame work comprises 3 important components namely:

A. Component 1: The Institutional Functionalities

This component includes the basic aims and objective.

B. Component 2: The ICT security architecture framework

This encompasses the core ICT security functionality and is composed of 7 layers.

Layer 1: ICT-Enabled security layer

Layer 2: Risk assessment and analysis

Layer 3: Risk Mitigation initiatives

Layer 4: Solution Design:

Layer 5: Operationalize and enforce solution:

Layer 6: Maintain and improve infrastructure security

C. Component 3: The final Outcome

10. LIMITATION OF THE STUDY

This research study, like other research studies has certain limitations. Some of these are:

- It covers geographical area Pune which is quite industrially and academically developed. Findings could have been different in case of smaller cities.
- Certain deeper technical aspects of PCs and Servers have not been covered as the study is more Management oriented.

- Statistical comparison between rural and urban has not been done which researcher is considering to do via Research papers.
- Medical institutions and simple Undergraduate courses like BA, B.Com, etc. colleges have not been covered.
- University which is the highest body for imparting higher education has not been individually studied.

11. SCOPE FOR FURTHER RESEARCH

The Researcher wanted to conduct a deeper study on the ICT infrastructure and its security but due to time constraint this was not possible. Thus, this study has left open certain areas for research and created new ones which researcher would like to himself undertake as post-doctoral research or they can be used by researchers in future. Some of these areas are:

- Study of ICT infrastructure in agricultural educational institutions located in Rural areas.
- Study of ICT infrastructure in Diploma-level educational institutions.
- A study of ICT security audit system in educational institutions.
- A study of ICT infrastructure in schools / graduate level colleges in tier-2 cities.

12. CONTRIBUTION OF RESEARCH TO EXISTING BODY OF KNOWLEDGE

The suggestions will give clear cut guidelines for managing the implementation and maintenance of ICT which will become the baseline for the higher technical education facilitators in the country.

Government has made many policies relevant to this area of study but have some problems at implementation level, these have been pointed out and remedies have been suggested in the study.

Mr. Abiresh Abraham	**Dr. Vilas D. Nandavadekar**
Research Student	Research Guide