The Impact of Electronic Customer Relationship Management (e-CRM) on Customer Satisfaction: A Study of High Performance Computing Facility (HPCF) at University of Hyderabad.

Doctoral thesis submitted to University of Hyderabad in partial fulfillment of the requirements for the award of the degree of

DOCTOR OF PHILOSOPHY
IN
MANAGEMENT

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DECLARATION

I, E. A. Vinod Kumar hereby declare that this thesis entitled, **"The Impact of Electronic Customer Relationship Management (e-CRM) on Customer Satisfaction: A study of High Performance Computing Facility (HPCF) at University of Hyderabad",** submitted by me under the guidance and supervision of Professor V. Venkata Ramana is a bonafide research work which is also free from plagiarism. I also declare that it has not been submitted previously in part or in full to this University or any other University or Institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in shodganga/INFLIBNET.

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CERTIFICATE

This is to certify that the thesis entitled, "**The Impact of Electronic Customer Relationship Management (e-CRM) on Customer Satisfaction: A study of High Performance Computing Facility (HPCF) at University of Hyderabad**", submitted by Mr. E.A. Vinod Kumar bearing Regd. No.: 03MBOH07 in partial fulfillment of the requirements for the award of Doctor of Philosophy in Management is a bonafide work carried out by him under my supervision and guidance which is a plagiarism free thesis.

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ABSTRACT

Higher education, today, is undergoing a sea change at an enormous speed. Worldwide, Educational institutions are undergoing basic shifts in the way they operate and communicate with its "customers": students, alumni, faculty members, and staff members. It is not just the quality of knowledge generated with higher educational institutions and its availability to wider economy is becoming increasingly critical, but also how an institution does it. New technology-based tools for gathering and disseminating knowledge have become central element of today's education system.

The growth in technology, cost effective, , communication, high mobility, rise in quality of life pose challenges, in various sectors of mankind including education. The dynamic changes need to be understood for making better decisions through management of education systems. To meet the objective and aspirations of the students, researchers and the society, mere technology dose not suffice. It is also essential to intervene with an apt management strategy more in as e-CRM treating the students, researchers (users) and society as customers of the education system. e-CRM tools will aid in deriving useful, feasible and admissible information. Fast changing technological, economic, sociological, and governmental forces are altering education and the way it is managed, impacting institutions, teachers, students, funding sources, and society.

The study aims to investigate the impact of the electronic customer relationship management on customer satisfaction. The usage of the computing facilities has increased in many folds; moving it very difficult to manage and satisfy the Customers (Users). Therefore the study suggests the implementation of e-CRM at Centre for Modelling Simulation and Design. The High Performance Computing Facility at University of Hyderabad was chosen for the purpose of study.

The primary objective of the study is conceptualizing and implementing e-CRM strategies in service sector like High Performance Computing facilities. As HPC and supercomputer facilities have major three aspects like Computer Systems, Application Software and Skilled professionals.

The users are customers of the HPC submit their jobs to application software on a platform by taking the assistance of skilled professionals, if needed. The relation with these user will have the impact on the above three components. Henceforth following specific study has been arrived at.

The Study is aimed at addressing the problem "Impact of e-CRM on Customer Satisfaction in HPC Environment". In the context of HPC facility it is quite important to assess customer satisfaction with respect to the following factors: Availability of software packages, Accessibility to the facility, level of usage, level of personalization and Fulfillment of requirements".

The research design strategy that been adopted for the current study is a combination of exploratory and descriptive designs. Empirical data from survey questionnaires offer possible experiences, explanations and the requirements.

For carrying out the study a questionnaire has been designed. The primary data has been collected by administrating the questionnaire, user logs at server level, interviews with a cross section of respondents including Faculty, Researchers and student users.

The scope of the study is restricted to understand the aspirations, satisfaction levels, and infrastructural management issues pertaining to very limited facilities due to its cost and maintainability aspects. To carryout the study on high performance computing and supercomputing facilities, (which are very costly, very advance system, 24x7 high availability and well maintained), it needs highly skilled professionals to maintain such systems, which are available in limited manner to the users and such facilities are essential for bringing out high quality and impacting research out comes as well as developing the human resources (skilled manpower).

The study revealed that a customized e-CRM will enhance the system performance in all dimensions. Some of the key recommendations for HPC environment include A Graphical user interface for job submission process with associated options embedded in e-CRM to enhance the HPC user satisfaction. Enabling effective web services facilities by coupling with authorization, authenticating by protecting privileges and support will create an additional dimension to e-CRM to access location independent services. A personalized graphical user interface, integrating user group information, year of registration and application specific e-CRM will enhance the user satisfaction levels as well as throughput of HPC with high level security options for the data.

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Abbreviations:

AGCMs	Global Atmospheric Models
AICTE	All India Council for Technical Education
ANURAG	Advanced Numerical Research Group
BARC	Bhaba Atomic Research Center
BI	Business Intelligence
CABE	Central Advisory Board of Education
CAE	Computer aided engineering
CARE	Conformity Assessment Requirements'
CCSD	Coupled cluster at Singles and Doubles
CCSM	Community Climate System Model
C-DAC	Center for Development of Advanced Computing
C-DoT	Center for the Develop of Telematics
CLV	Customer Lifetime Value
CMMACS	Center for Mathematical Modelling and Computer Simulation
CMSD	Center for Modelling, Simulation and Design
COL	Commonwealth Of Learning
CRL	Computational Research Laboratories
CRM	Customer Relationship Management
DCC	Digital content creation
DEC	Distance Education Commission
DGP	Director General of Police
DIT	Department of Information Technology
DR	Disaster Recovery
e-CRM	electronic Customer Relationship Management
EDA	Electronic design and automation
ERNET	Education and Research Network
ERP	Enterprise Resource Planning
FICCI	Federation of Indian Chambers of Commerce and Industry
GDP	Gross Domestic Products
GePNIC	Government eProcurement Solution of NIC
GER	Gross Enrolment Ratio
GIA	Grant-In-Aid
GLORIAD	The Global ring network for advanced applications development
HEIs	Higher Education Institutions
HPC	High Performance Computing
HRD	Human Resource Development
ICT	Internet Communication Technology

IDC	Internet Data Center
IEI	India Education Index
IGNOU	Indira Gandhi National Open University
IISc	Indian Institute of Science
IIT-D	Indian Institute of Technology, Delhi
IITM	Indian Institute of Tropical Meteorology, Pune
IITs	Indian Institute of Technology
IMD	India Meteorological Department
IMSC	Institute of Mathematical Sciences, Chennai
INCHER	National Commission for Higher Education and Research
INCOIS	Indian National Center for Ocean Information Services
INOC	Integrated Network Operations Center
IT	Information Technology
JNCASR	Jawaharlal Nehru Center for Advanced Scientific Research
KBCS	Knowledge Based Computer Systems
KMS	Knowledge Management System
LANs	Local Area Networks
MAHE	Manipal Academy for Higher Education
MANs	Metropolitan Area Networks
MC	Monte Carlo
MNIC	Multipurpose National Identity Card
NAAC	National Assessment and Accreditation Council
NAL	National Aerospace Laboratories
NBA	National Board of Accreditation
NCBS	National Center for Biological Sciences
NCHER	National Commission for Higher Education and Research
NCMWRF	National Center for Medium Range Weather Forecasting
NIC	National Informatics Center
NITs	National Institutes of Technology
NPTEL	National Programme on Technology Enhanced Learning
NRENs	National Research and Education Networks
ODL	Open and Distance learning in India
OFC	Optical Fibre Cable
PoC	Proof of Concept
QAF	Quality Assurance Framework
R & D	Research and Development
RegCM	Regional Climate Model
ROMS	Regional Ocean Modelling System
RSBY	Rashtriya Swasthya Bima Yojana

SAC	Space Application Center, Ahmadabad
SERC	Supercomputer Education and Research Center
SWAN	State Wide Area Networks
TEIN3	Trans Eurasia Information Network link
TIFR	Tata Institute of Fundamental Research
TIFRAC	TIFR Automatic Calculator
UNDP	United Nations Development Program
VC	Video Conferencing
VPN	Virtual Private Network

1 Introduction

In the last two decades, new technologies have played a crucial role in human life and have greatly altered the lifestyle. E-business revolution has changed the landscape of Customer Relationship Management (CRM). The electronic Customer Relationship Management (e-CRM) applications have developed quickly from a new idea to a strategic imperative for businesses. Using Information Technology (IT), firms are moving towards intellectual and knowledge oriented based methods and CRM is becoming more effective. Using e-CRM in a company, connecting with customer results in faster feedback.

Companies that enter to compete in a new market weaken the existing and solid ones, due to new ways of doing and conceiving businesses. One of the factors that has been responsible for this constant change is the evolution of technology. Because of this reality, the CRM concept has evolved and must be viewed as a strategy to maintain a long-term relationship with the customers. A good customer relationship is the key to business success. Relationship building and management, or what has been labelled as relationship marketing, is a leading approach to marketing.

The use of Customer Relationship Management (CRM) systems is becoming increasingly important to improve customer lifetime value. Understanding the needs of customers and offering value-added services are recognized as factors that determine the success or failure of companies. By providing information on customer data, profiles and history, CRM supports important areas of a company's core processes, especially in marketing, sales and service. e-CRM is all about optimizing profitability and enables businesses to retain customers, as it makes the customers feel they are really a part of the business progress. When managing the transition to a customer centric organization, it is mandatory to develop the capabilities, to acquire the necessary resources, knowledge and tools in order to meet customers requirements with the appropriate products and services. An effective CRM system should enable an organization to gain greater insight into customer behavior and preferences.

1.1 Educational Institutes

Since long time People, have always been ready to accept manufactured products. So, companies introduced various products which were designed by their own Research and Development (R and D) centers and industries. The business professionals changed their mind from 'product-centric' business to 'customer-centric'. They understood how to attract customers. This not only led to more profits but a more loyal the customers base.

The Globalization and access to the Internet mean that the competition can now come as easily from around the world as from around the corner. Power in the form of the choice is moving into the hands of the customer as never before, leading to the customization of products and services in most situations. The Internet brings with it ubiquitous connectivity, real-time access and a simple universal interface provided by web browsers.

The major benefit for the customers is the ease of access to information related to various products, their attributes, the price ranges offered by the competitors etc. They can access this information using the Internet, without actually visiting the stores (via online shopping). The other factor is related to the availability of greater variety of goods and services and the ease of ordering them. Buyers can log on to websites of the companies and order these goods from anywhere in the world and get them delivered to their preferred address.

Developing countries like India are also witnessing these changes, and customers are realizing the benefits of using electronic channels for purchasing of goods and services. Customers today have the capability of accessing huge amount of information related to any area of their choice. Customers also have the facility of comparing products and services using the information available on the Internet. This has resulted in empowered customers.

Past research has shown that "the customers were reluctant to complain about poor professional service, such as education, but the same customers are becoming increasingly more value conscious. There is mounting pressure from the customers of higher education, i.e. students, parents and employers, to close the widening gap between their expectations of institutional performance and the actual performance. This indicates the importance of institutions of higher learning to monitor the quality of their services actively and to commit to continuous improvements in an effort to respond to the needs of the institutional constituencies".

1.2 Higher Education

1.2.1 Higher Education System in India

In ancient India education was highly advanced during period 7th century B.C. to 3rd century A.D. and it had a remarkable resemblance to the medieval European universities that came up much later. But this education system disappeared owing to foreign invasions and disorder within the country.

There were 3 distinct traditions of advance scholarship, Hindu gurukulas, Buddhist vihars and Quranic madrassas and it continued till the advent of the British who established schools to impart western education. However, after independence this higher education system grew rapidly, As a result, India is the third largest in terms higher education system in the world.

Most of the universities and colleges in India offers multidisciplinary programmes and there are some other universities which are confined to a particular discipline such as agriculture, law, technology, medicine etc. Apart from these universities and colleges there are also institutions like IIMs, IITs, and IISc which award diplomas equivalent to the degrees offered by the universities.

Higher education in India comprises there levels of qualifications i.e., Bachelor (or Under Graduate), degree: Master (or Post Graduate), and Pre-doctoral and Doctoral programme i.e., Master of Philosophy and Doctor of Philosophy.

Till 1980, the growth of higher education was confined to arts, science and commerce, the govt. had supported higher education and also institution setup through the private sector. Apart from these universities, colleges and institutions there emerged a system of distance education in the early 1990s through Open Universities.

These Open Universities cater to the needs of 2.8 million students with about 1.3 million students registering for various courses each year. This system of distance education is considered to be an economical and quick way of increasing enrolment in higher education.

Apart from these Indian universities, colleges or institutions, the number of foreign education providers is comparatively small. Higher education is a powerful means to build up a knowledge based society. But it is facing certain challenges in terms of access, equality and quality. To obviate these challenges, the govt. of India has taken several initiatives during 11th Five Year Plan period, and yet in terms Gross Enrolment Ratio (GER). India is still lagging behind, though it has established itself as largest education system in the world in terms of no. of institutes and third largest in terms the of student enrolment.

Table 1: Type-wise classification of Universities in India

Sl. No	**Type of Institution**	**No. of Institutions (As of 2006)**	**No. of Institutions (As of 2013)**
1	Central Universities	20	44
2	State Universities	217	310
3	Private Universities	8	168
4	Institutions Deemed to be Universities	104	129
	Total	349	651

(Source: UGC Report 2012-13)

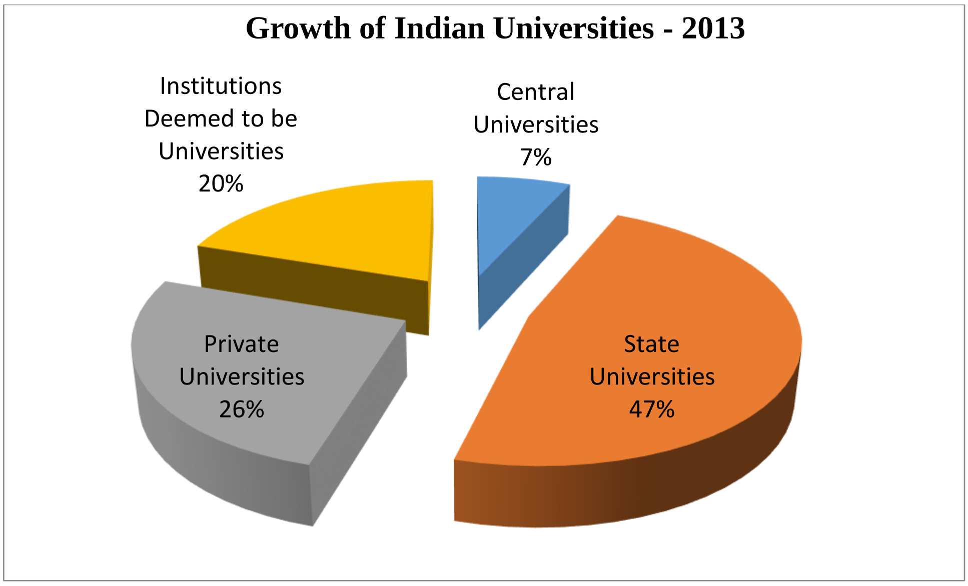


Figure 1 : Growth of Indian Universities - 2013

(Source: UGC Report 2012-13)

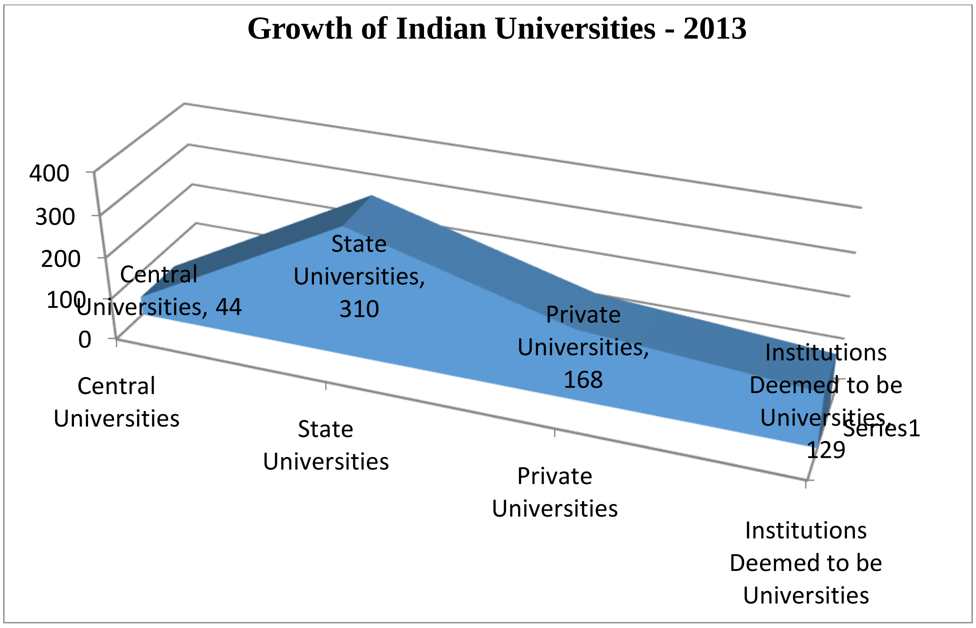


Figure 2 : Growth of Indian Universities - 2013

(Source: UGC Report 2012-13)

1.2.2 Some quick facts about Indian Higher Education

There were 14.6 million students undergoing Higher Education in India as of 2011.

1. There has been a significant rise in enrollment from rural population in Higher Education. The GERs in rural areas have been rising steadily and are expected to reach 12.84% by 2020.
2. A growing number of women are expected to enroll in Higher Education Institutes (HEIs). Currently over 6.1 million women are enrolled in Higher Education and this number is expected to grow to12.15 million by 2020.
3. There is a high demand from working professionals for Executive Education programmes.
4. Three Indian universities were listed in the Times Higher Education list of the world's top 200 universities are "Indian Institutes of Technology, Indian Institutes of Management, and Jawaharlal Nehru University in 2005 and 2006. Six Indian Institutes of Technology and the Birla Institute of Technology and Science,(Pilani) were listed among the top 20 Science and Technology Schools in Asia by Asia Week. The Indian School of Business located in Hyderabad was ranked number 12 in global MBA rankings by the Financial Times of London in 2010 while the All India Institute of Medical Sciences has been recognized as a global leader in medical research and treatment".

   (Source: UGC Higher Education in India 2008 - 11th Five Year Plan Vol. II)

In India all the universities are required to be accredited and are allowed to award degrees.

The UGC has established the following autonomous institutions to look after the accreditation of universities

- All India Council for Technical Education (AICTE)
- Distance Education Council (DEC)
- Indian Council of Agricultural Research (ICAR)

- Bar Council of India (BCI)
- National Assessment and Accreditation Council (NAAC)
- National Council for Teacher Education (NCTE)
- Rehabilitation Council of India (RCI)
- Medical Council of India (MCI)
- Pharmacy Council of India (PCI)
- Indian Nursing Council (INC)
- Dental Council of India (DCI)
- Central Council of Homeopathy (CCH)
- Central Council of Indian Medicine (CCIM)
- Veterinary Council of India (VCI)

1.2.3 All India Council for Technical Education (AICTE)

While the conventional universities, colleges and certain other institutions taking care of the field of arts, science, commerce and other specialized fields, there was a necessity for imparting technical education in India, and based on the recommendations of the CABE, AICTE was set up in Nov. 1945. At that time, it was confined only to programmes of Engineering and Technology. Post-independence with the growth of the industries in the country, there was a need for qualified professionals in fields like Business Management, Architecture, Health Management, Pharmacy etc.

In order to meet this demand "the govt. of India set up a Board of Management Studies under the AICTE to formulate standards and promote Management education. Due to the implementation of the successive Five Year Plans and certain policy changes in mid-80s, the growth of Technical Education has been phenomenal".

1.2.3.1 Growth of Technical Education

The growth of Technical Education before independence in the country was very slow. "The number of Engineering colleges and Polytechnics (including Pharmacy and Architecture institutions) in 1947 was 44 and 43 respectively (with an intake capacity of 3200 and 3400 respectively). Due to the efforts and initiatives taken up during the successive Five Year Plans and particularly due to policy changes in the 80s to allow participation of private and voluntary organizations in the setting up of Technical institutions on a self-financing basis, the growth of technical education has been phenomenal".

Table 2: Growth of technical institutions in the country

YEAR	Engg	Mgmt	MCA	Phar	Arch	HMCT	Total	Added in Year
2006-07	1511	1132	1003	665	116	64	4491	171
2007-08	1668	1149	1017	854	116	81	4885	394
2008-09	2388	1523	1095	1021	116	87	6230	1345
2009-10	2972	1940	1169	1081	106	93	7361	1131
2010-11	3222	2262	1198	1114	108	100	8004	643
2011-12	3393	2385	1228	1137	116	102	8361	357
2012-13	3495	2450	1241	1145	126	105	8562	201

(Source: AICTE Approval Process Handbook: 2013-2014)

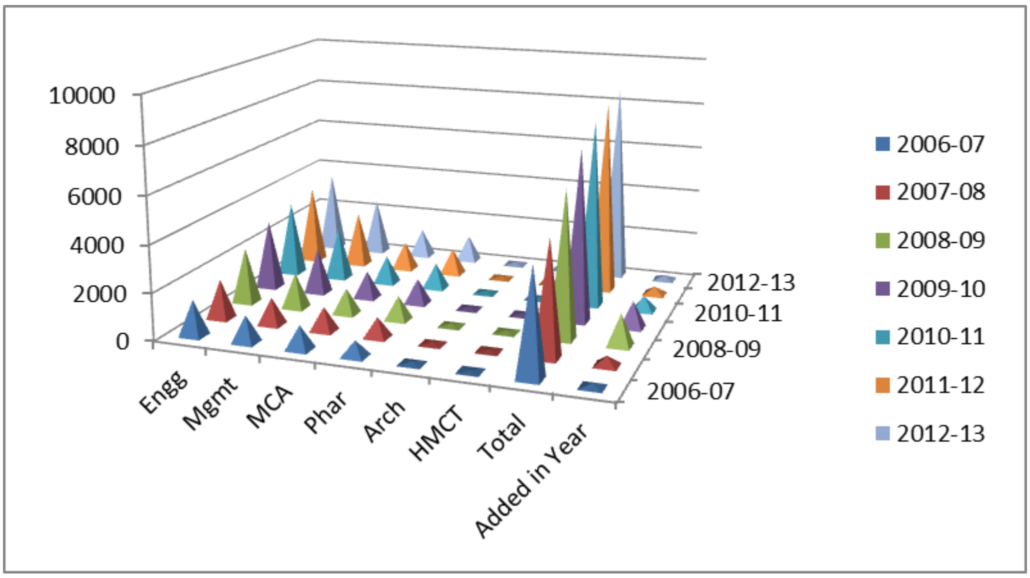


Figure 3 : Growth of Technical Institutions in the Country

(Source: AICTE Approval Process Handbook: 2013-2014)

The AICTE has 8 departments:

- Administration Bureau
- Academic Bureau
- Engineering and Technology Bureau
- Finance Bureau
- Management and Technology Bureau
- Planning and Co-ordination Bureau
- Quality Assurance Bureau
- Research and Institutional Development Bureau

Though new technology-based tools for gathering and disseminating knowledge have become central to today's education system, Customer Relationship Management (CRM) should not be mistaken to be a technology only. It is more than mere technology. Lots of people consider CRM a software or a tool. If the data collected is correct, then an advanced CRM technology can provide near accurate process information. Fast changing technological, economic, sociological, and governmental forces are altering education and the way it is managed, impacting institutions, teachers, students, funding sources, and society.

Higher academic institutions are needed to develop strategies that make them more receptive and responsive to students. Students increasingly see themselves as customers who purchase education services from competing institutions. These days, students are more assertive while demanding more of educational institutions. Institutions must make an effort to meet students' enhanced expectations. If this is not done, then it might lead to a high level of dissatisfaction among students and institutions might lose the students and also its value. As Kotler and Fox (1995) state, that the best organization in the world will be ineffective if the focus on ‘customers is lost. First and foremost is treatment of individual students, alumni, parents, friends, and each other (internal customers). Every contact counts!

Customer Relationship Management is all about satisfying and retaining the customer by providing the perquisites he/she desires for. The relations that are maintained are a kind of trust that the institutions provide to its customers (students) and fulfill them. The organizations are focusing on CRM not only to impart state-of-the-art education to their students, but also to maintain relations with their working staff, administrators, companies, vendors and with their primary customers are students. CRM’s main function is to the maintain relationships in the organizations”.

CRM is a “comprehensive strategy and process of acquiring, retaining and partnering with selective customers to create superior value for the organization and to customer”. The main activity of CRM is to improve marketing productivity. Sheth and Sisodia 1995 states, “Marketing Productivity is achieved by increasing marketing efficiency and by enhancing marketing effectiveness”. In CRM, marketing efficiency is achieved by cooperation and collaborative processes help in reducing transaction costs and overall developmental costs for the organization.

Customer Relationship Management (CRM) is the business strategy to acquiring, retaining and partnering with the target group of customers. “It is a set of distinct software tools, with the aim of reducing costs, enhancing profit, recognizing new opportunities and channels for expansion, and improving customer value, satisfaction, profitability, and retention. CRM software combines best practices with advanced technologies to help organizations to achieve these goals. CRM aims at automating and improving the institutional processes in managing customer relationships at various touch points in the areas of administration, recruitment, marketing, communication management, service, and support”. CRM considers customer as epicenter of activities around which all organizational functions revolve.

Our country's higher education system is having a quality problem. "In the world of competitive academic environment, students are having many options available. Therefore it is important to find the factors that are enables education institutions to attract and retain students. Higher education institutions which want to gain competitive edge in future may need to begin searching for effective and creative ways to attract, retain and foster stronger relationship with students".

1.3 Information and Communication Technology - (ICT)

1.3.1 Role of ICT in Higher Education

Education is the backbone of a nation. "Education system plays a major role in development of modern economies. Understanding how education system work and how it evolved over time has been one of the most important research agendas in recent years. The education system of any economy performs following main tasks: first, it handles the basic and higher education; second, it provides better opportunities of income; third it enhances the living standard and helps in social development".

Information, Knowledge, and Communication Technology plays vital role in imparting education in modern scenario. At the height of the Internet boom of the 1990s, a fashionable saying was the Internet changes everything. The ICT changed the way of imparting education in modern era. Considering the higher education in India has seen the massive growth in post-independence era. At the time of independence 17 universities and about 400 colleges was there in India and today 520 universities, nearly 22,000 colleges, over 10 million students, 0.45 million teachers and one of largest higher education system in the world. Our education system focuses on the creation of high quality and well trained human resources to fulfill the needs of ever growing Indian economy, but on the other hand it faces challenges at operational level. Educational governing bodies like UGC, AICET, ICMR, ICAR, all face difficulties to maintain proper coordination, administration, monitoring and evaluation for improving the quality of education and imparting the education".

The role of Information and Communication Technology (ICT) "plays a great role in strengthening the three traditional branches that make up the mission of higher education i.e. teaching, research and service to the society. ICT changed the style of functioning of the educational system and its governance with the help of digital data, its storage, retrieval, manipulation and transmission. ICT works in three ways: - (i) communication and decision implementation, (ii) automating tedious task, and (iii) supporting new and existing tasks and processes".

Use of Information and Communication Technologies (ICTs) can process information, create knowledge base and make them available wherever and whenever necessary. "ICTs in most cases have tremendous success in providing services at reduced costs at the customers door steps. ICTs have the same thing to do for making the higher education available to all classes of people throughout the country at a lower cost. This will allow people to have the access right of higher education and also will gain the necessary knowledge, skills, and experiences to serve the nation and prosper accordingly".

Currently, with the development of ICTs, the higher education through distance mode has been more practical and well accepted by all the people around the globe. It is now being called Virtual learning. In a developed country, people are getting more interested in learning through Virtual Campus than that of a on campus. Virtual campus is nothing but ICT enabled campus, where students are attending their classes, discussing with teachers, accessing learning resources, attending exams, joining forums/clubs, submitting assignments etc. virtually having the facility of real-time interactions between teacher and students.

ICT is defined "as new information processing and information transmitting technologies that include computer related commodities and technologies such as broadcasting and wireless mobile telecommunications etc. Personal computer (PC) that connects Internet has become a vital tool for communication during the past few decades since its proliferation among the masses. It is observed that penetration of ICT is faster in developed nations rather than developing nations. The penetration of ICT can be linked to socio-economic conditions of a nation such as education, freedom for information exchange, promotion of basic telecommunications infrastructure and market. Therefore, the objective of the paper is to analyze, growth pattern of enrollment and the relationship between level of education and diffusion of ICT; focuses on Internet and personal computers (PCs)".

Open and Distance Learning: "Open and Distance Learning is defined by the Commonwealth of Learning as a way of providing learning opportunities that is characterized by the separation of teacher and learner in time or place, or both time and place; learning that is certified in some way by an institution or agency; the use of a variety of media, including print and electronic; two-way communications that allow learners and tutors to interact; the possibility of occasional face-to-face meetings; and a specialized division of labour in the production and delivery of courses."

The use of ICT has extended the scope of offering educational programmes at a distance. "The off-campus delivery was an option for students who were unable to attend the classes regularly. Today, many students are able to make this choice through technology- facilitated learning settings. This make available the education everywhere, it is time and cost saving also. The major benefit of ICT implementation in education is its extending courses of choice to students of different backgrounds, cultures, perspectives. Learners are free to participate in learning activities at their convenience through online technologies".

Eminent teachers from different parts of the country and abroad can be utilized for teaching at their convenience through mobile technologies and seamless communication technologies that support 24x7 teaching and learning for instance NPTEL (National Programme on Technology Enhanced Learning, India,2007), EKLAVYA Technologies Channel, India, 2007, Tata Sky Active education classrooms etc. All these above technologies are the fruitful result of ICT implementation in education sector which provide a new direction in modern education. All these education can be provided through Teleconferencing, Videoconferencing, Web-based conferencing, Audio conferencing and other ICT technologies.

Teleconferencing: refers to "interactive electronic communication among people located at two or more different places. There are four types of teleconferencing, 1) audio conferencing; 2) audio-graphic conferencing, 3) video conferencing; and 4) Web based conferencing".

Audio conference is "involves the live (i.e. real-time) transmit of voice messages over a telephone network. When low-bandwidth text and images such as graphs, diagrams or pictures can also be transmit along with voice messages, is called audio-graphic conference. Non-moving visuals are added using a computer keyboard or by drawing/writing on a graphics tablet or whiteboard".

Video conference allows to transmit not just the voice and graphics but also of moving images. Video conferencing technology uses the satellite link or a television network (broadcast/cable).

Web based conference is involves the transmission of text and graphic, audio and visual media via the Internet, it requires the use of a computer with a browser and communication media with synchronous and asynchronous.

The development of Information Technology, "particularly the World Wide Web (WWW), as an electronic medium of commerce has brought tremendous changes in how companies compete in today's new economy. Internet technologies provide companies with tools to adapt the changing customers needs and could be used to secure economic, strategic and competitive advantages. Companies that do not take advantage of Information technology cannot deliver the value added services to their customers, and this can be a disadvantage. In contrast, companies that utilize this technology (i.e. web site to displays the corporate and products information) are viewed as progressive and continuously striving to meet the current needs of customers."

This general industrial trend has created tremendous cost pressures on traditional businesses. Both companies and customers acknowledge that the Internet can be seen as an effective tool for disseminating information. From a marketing perspective, the internet is not merely another marketing tool, it can be a strategic tool to help companies increase consumer satisfaction; retain customers as well as to acquire consumer loyalty. Hence, Internet technology is imperative in managing customer relationships for e- businesses.

Competition becomes immensely intense "as the number of Internet companies and users is growing rapidly. Many companies are facing difficulties in distinguishing themselves from competitors and in acquiring new customers. Gronroos 1994; McKenna 1991; Morgan and Hunt 1994; Zineldin 2000 many companies seem to continuously rethink new ways of generating sales and increasing profits. These attempts include, among others, strategizing for the 'new paradigm' of relationship marketing."

When the company has a "vast consumer base with limited direct contacts with its customers, a relationship approach is less obvious, but could well be profitable and possible for example, (Ab Hamid and Kassim 2004) through the development of information technology and interactive media. The elements of interactivity (Furash 1999; Walsh and Godfrey 2000) and the ability to capture useful information from Internet technology have spurred internet in the feasibility of streamlining information provided, forecasting customers needs, understanding preferences, delivering personalized services and enabling customization."

1.4 Educational Networks

1.4.1 Role of National Informatics Center (NIC)

The National Informatics Center (NIC) is the premier science and technology organisation of India's Union Government in informatics services and Information and Communication-technology (ICT) applications.

NIC has a major role in developing "e-governance applications in the governmental departments at national, state and district levels, enabling the improvement in, and a wider transparency of, government services. Almost all Indian government websites are developed / managed by NIC".

1.4.2 Network

NIC offers telecommunications networking services including "K_u band (Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Single channel per carrier (SCPC) and Satellite Broadband) Very Small Aperture Terminals (VSATs), wireless Metropolitan Area Networks (MANs) and Local-Area Networks (LANs) with gateways for Internet and Intranet resource sharing".

It has "the network infrastructure and e-governance support to India's central government and state governments, union-territory administrations, administrative divisions and other government bodies. The NIC assists in implementing information technology projects, in collaboration with central and state governments, in the areas of Information Communication and Technology (ICT)".

1.4.3 NIC Setup

NIC is a part of the "Indian Ministry of Communications and Information Technology's Department of Electronics and Information Technology and is headquartered in New Delhi. It has offices in all 28 state capitals and 7 union-territory headquarters and almost all districts. At New Delhi Headquarters, a large number of Application Divisions exist which provide total Informatics Support to the Ministries and Departments of the Central Government. To cater to the ICT needs at the grassroots level, the NIC has also opened offices in almost all district collectorates. NIC extends technical coordination and IT support to District Administration".

NIC computer cells are "located in almost all Ministry bhavans (buildings) of the central government and offices including the Indian Prime Minister's office, the Indian Presidential Palace (Rashtrapati Bhavan) and India's Parliament House (Sansad Bhavan).It also provide support to grass root level administration".

The services provided by the NIC including:

- Computer-Aided Design (CAD)
- Digital-Signature Certification
- Geographical-Information System (GIS)
- domain-name registration for gov.in and nic.in
- Informatics
    - Biomedical informatics
    - Patent informatics
    - Rural informatics
    - Agriculture informatics, including hydrography
- Internet Data Center (IDC)
- Mathematical modelling and simulation

- Computer networking
- Office-Procedure Automation (OPA)
- Training
- Cyber Security
- Videoconferencing
- Website hosting and website development
- Internet Services

1.5 Role of Education and Research in Computer Networking (ERNET)

Education and Research in Computer NETworking (ERNET), "India is an autonomous scientific society under the administrative control of the Department of Information Technology, Government of India is the largest nationwide terrestrial and satellite network with 15 points of presence located at the premier academic and research institutions in major cities of the country. Focus of ERNET India is not limited to just providing connectivity, but to meet the entire needs of the academic and research institutions by providing consultancy, project management, training and other value added services such as web hosting, e-mail services, video conferencing, domain name registration services".

ERNET India is "serving more than 1300 institutions in various sectors, namely, health, agriculture, higher education, schools and science and technology. ERNET was also identified by Government of India as the nodal network for India and was connected through high-speed link to the pan-European Education and Research Network (GEANT) during 2006 to 2010. The ERNET-GEANT connectivity is now available through Trans Eurasia Information Network (TEIN3)".

1.5.1 Network

ERNET India is running Multi-Protocol Label Switching (MPLS) enabled dual stack (Internet Protocol version 4 (IPv4) and Internet Protocol version 6 (IPv6)) backbone. "The ERNET backbone interconnects ERNET Point of Presence (PoP) spread throughout the country. The ERNET PoP at Software Technology Parks of India (STPI), Bengaluru integrate ERNET VSAT network with ERNET terrestrial network. ERNET has deployed many overlaid network over its backbone. The domestic traffic is routed via National Internet Exchange (NIXI) whereas international traffic from each PoP is routed out as ERNET is peering with upstream service providers at each PoP for faster access to Internet". Following are the salient features of ERNET backbone:

- Multi-Protocol Label Switching (MPLS) Enabled.
- Supports dual stack of IPv4 and IPv6.
- High Capacity Backbone.
- Scalable, Secure and Guaranteed QoS.
- Supports IPv4/IPv6 MPLS VPN Services.
- Enabled for Multicast.

1.5.2 Services

1. In tune with the mandate ERNET is providing four types of services, namely, Access Services, Application Services, Hosting Services and Operations Support Services to all Educational and Research Community of India.

2. ERNET provides access to its network through various connectivity options. Application services include E-mail hosting, domain registration, MPLS VPN. It also provides Web Services having state of the art of Data Center.

3. Other services include IT Consultancy and Project Management services for establishment of IT infrastructure and converged Network Projects.

1.5.3 Research and Development

ERNET India is actively involved in research and development in the field of computer networking. Current areas of interest include high speed networking, network management, wireless sensor networks, future internet research, mobility in IP networks, cloud computing etc. The R and D efforts initiated by ERNET core groups have resulted in product development and technology transfer to the industry.

The following are the ongoing R and D projects

- MyFIRE
- EU-India Grid
- 6LoWPAN
- Mobile IPv6
- Earlier Projects

1.5.4 Training

The functions of ERNET India are characterized by advanced technologies of diverse nature in the field of high end and next generation networks, LAN/WAN, Campus Networks, ICT and Voice/Video conference systems. Technology is advancing very fast and with a view to keep updated with the latest technology ERNET India undertakes training activities either through its own resources or through external agencies.

ERNET has conceptualized, developed and implemented large number of projects on turn-key basis for various Educational Institutes and Research Organization. Several National and International Projects have been done by ERNET India.

ERNET India has also organized a number of training programmes catering to specific requirements of its user communities from various domains belonging the UGC, ICAR, Defense, KVKs, etc...

1.5.5 Projects

National

- ICT Vocational Centers for Disabled Students
- ICT Centers for rural Schools
- Repository of Digital Library
- CIC-VV
- Cyber Forensics
- E-Linkage of Jawahar Navodaya Vidyalayas
- E-Linkage of Kendriya Vidyalayas
- E-Linkage of Krishi Vigyan Kendras under ICAR
- Data Center
- Campus Network
- Video Conferencing
- 6LowPAN
- Mobile IPv6
- VSESS

International

- TEIN3
- MY –FIRE
- EU-India Grid2

1.6 Role of National Knowledge Network (NKN)

The main objective of the "National Knowledge Network (NKN) is to interconnect all institutions of higher learning and research with a high speed data communication network to facilitate knowledge sharing and collaborative research. It will bridge the existing knowledge gap in the country. It will help the country evolve as a Knowledge Society and spur economic activities in the Knowledge domain".

National Knowledge Network (NKN) is established a strong and robust Pan-India network, which provides secure and reliable connectivity with a quantum jump in bandwidth.

Globally, "research and development activities and innovations are increasingly multidisciplinary, collaborative, and require substantial computational power. The key to successful research today demands live consultations, data sharing and resource sharing". Therefore in order to "optimally utilize the potential of institutions engaged in generation and dissemination of knowledge in various areas, it is important to connect them through a high speed broadband network".

The NKN "comprises of an ultra-high speed CORE (multiples of 10 Gbps), complimented with a distribution layer at appropriate speeds. Participating institutions at the Edge will connect to the NKN at speeds of 1 Gbps or higher. The network is designed to support Overlay Networks, Dedicated Networks, and Virtual Networks. Advanced applications in areas such as Health, Education, Science and Technology, Grid Computing, Bio informatics, Agriculture, and Governance will be an integral part of NKN. The entire network will seamlessly integrate with the global scientific community at multiple gigabits per second speed."

The purpose of such a "knowledge network goes to the very core of the country's quest to build quality institutions with requisite research facilities and create a pool of highly trained persons. The NKN while impacting the existing academic and student community will also alter the R and D landscape for future generations".

NKN is a revolutionary step towards creating a knowledge society without boundaries. It will provide unprecedented benefits to the knowledge community and mankind at large. "Using NKN as a backbone, institutions with a vision and passion for their field of work have been able to transcend the limitations imposed by space and time. Accessing information and deriving the associated benefits of knowledge on a high speed network have become a reality. Establishing NKN is a significant step towards ushering in a knowledge revolution in the country by connecting over 1000+ institutions. NKN is intended to connect all 1500+ knowledge and research institutions in the country by using high bandwidth / low latency light paths, thus creating an e-Infrastructure for India".

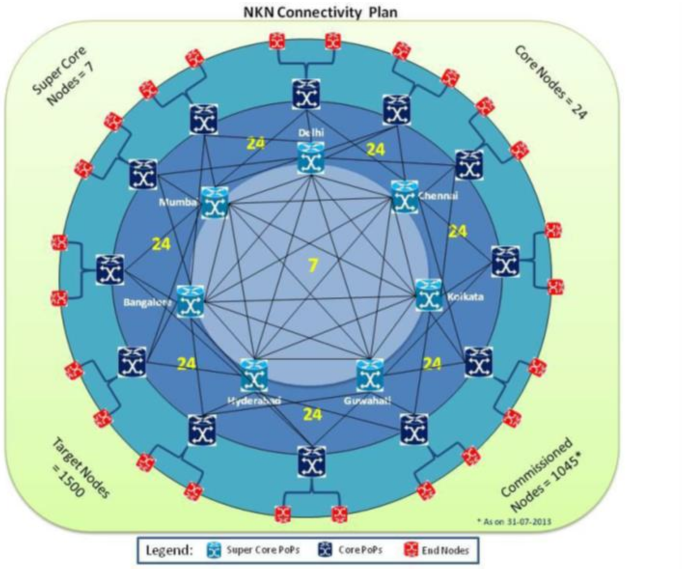


Figure 4 : NKN Connectivity Plan

(Source NKN Report-2011)

NKN provides the common platform to "all the users from science, technology, higher education, healthcare, agriculture and governance to share the information/data/knowledge without any bottlenecks".

The "research and innovation is shifting towards a multidisciplinary and collaborative paradigm requiring substantial communication bandwidth and high end computational power. NKN with its multi-gigabit capability aims to connect all universities, research institutions, libraries, laboratories, healthcare and agricultural institutions across the country to address such a paradigm shift. The network design is highly scalable and takes into account the future requirements that would need to be addressed as the network grows. NKN is bringing a knowledge revolution that will be instrumental in transforming the society and promoting inclusive growth".

1.6.1 NKN Connectivity Plan

NKN "backbone is fully meshed with 7 Super Core locations which initially had a 2.5 Gbps bandwidth, and has now migrated to 10 Gbps. The network is deployed through 24 Core distributed locations with multiple of 2.5/10 Gbps links. The distribution layer connects the entire country to the core of the network using multiple links at speeds of 2.5/10 Gbps. The end users are being connected to links of 100 Mbps or up to a speed of 1 Gbps".

The "network architecture and governance structure allows users with the option to connect to the edge or distribution layer. NKN enables creation of Virtual Private Networks (VPN) for special interest groups. NKN provides international connectivity to its users for global collaborative research. The International connectivity with a 2.5 Gbps link between NKN and GEANT through the TEIN4 project. Western Coast of India is connected with the Europe POP of GEANT. The Eastern Coast of India is connected with a 2.5 Gigabit link to the Singapore POP". NKN is also working on establishing high bandwidth connectivity with USA and Japan.

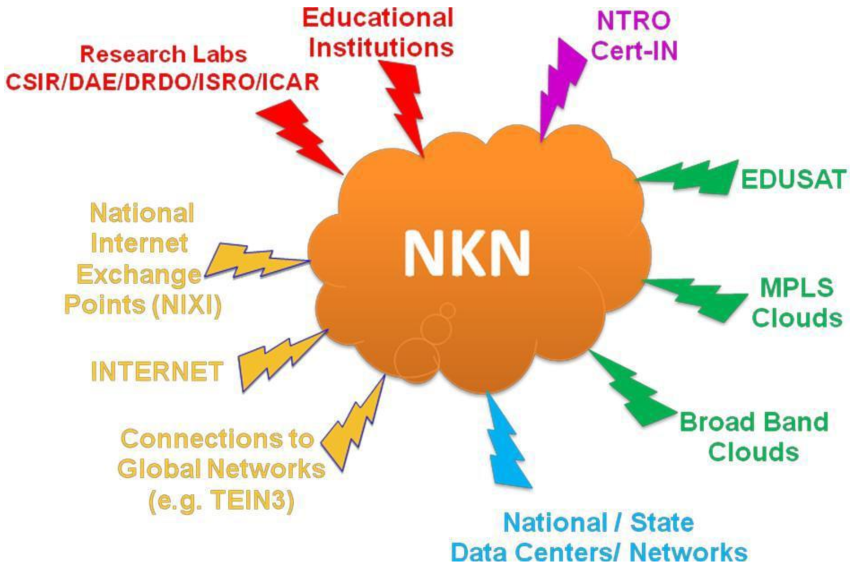


Figure 5 : NKN Overview

(Source NKN Report-2011)

Currently, NKN is "functional with 7 super nodes (in a mesh topology) and 24 core nodes connecting over 1000 institutes. The objective is to connect the remaining institutes by March 2014. In addition, 66 virtual classrooms have also been established across NKN nodes. The NKN Grid infrastructure consists of Garuda Grid, DAE Grid and regional LHC computing Grid. Many applications such as Collab-CAD, Open Drug Discovery project of CSIR and ESRF synchrotron remote operation and control are running on NKN".

National Research and Education Networks (NRENs) are now more than an operational platform for communications. They are the engines driving the pace of collaboration, innovation and discovery amongst scientists. The role of a National Research and Educational Network is critical to the achievement of stated national education and research goals. India is on the verge of doubling its high performance computing capacity and is exploring opportunities to integrate with global research and education networks.

Education institutions should become places where information is always accessible in context, communications can be easily achieved with any corner of the world and intensive collaboration increases the pace of knowledge generation. Many leading MNC's have R and D labs and development centers in India. Yet these companies choose to conduct their research and development with universities in other countries where these networks exist. This needs to be changed if India is to move up the value chain and become the R and D outsourcing destination. One means of achieving this change is through expansion of Research and Education Networks.

There are currently three educational networks in India, namely, the Education and Research Network (ERNET) and BIOGRID (a Virtual Private Network of the Department of Biotechnology, Govt. of India) and GARUDA (Grid Computing Institutive). Each serves its respective client bases. ERNET is the exclusive provider of international connectivity to all Higher Education institutions. These networks have emerged and grown from the demand by the end user organizations to have connectivity to similar organizations both nationally and internationally. All networks deliver network connectivity, including Internet access, to Universities, Institutes of Technology and other various Government agencies on a national basis. Private sector operators provide further, international connectivity via cable and satellite for personal and commercial consumption.

The activity of providing networking to education and research users is seeing dramatic change (including hospitals, libraries, schools, incubation facilities). Research capacity is seeing a major developmental drive, technology is becoming central to the delivery of education and furthermore the telecommunications market has become rapidly transformed.

In the knowledge economy of the 21^{st} Century, for which India has positioned itself with investments and capabilities in IT/ITES-BPO, Biotech and R and D, the future worker-would need to be familiar with the use of ICT, just as much as reading, writing, and arithmetic were foundations of the industrial age. The advantages of broadband include:

a) Sharing of knowledge enhanced by equitable access to the Internet, which is considered as a source of information for education, scientific, economic, social, political and cultural activities i.e. provide universal access to knowledge a fundamental human right.
b) High speed communication on the internet enable exchange of vast amounts of content and data on as always on mode facilitating traditional face-to face services such as education, health, administration and government traditional hierarchy of distance and time.
c) Video conferencing can occur at a variety of relatively low connection speeds. On the other hand-data set transfers for physical and biological research require larger "pipes" (i.e. connections) so that instead of months/days it takes mere hours/minutes a researcher to send/receive data.

The benefits from high performance computing networks can be enormous. The principle objective is to put together information infrastructures, which enable global collaboration among various stakeholders, especially universities and R and D labs, thereby improving India's innovation ecosystem.

1.7 Summary

In this chapter, discussed about the growth of Higher education and Technical education in India. Role of Information and communication Technology in Higher education and role of ERNET (Education and Research NETwork), National Knowledge Network (NKN), in High Performance Computing Facility environment.

2 e-CRM and High Performance Computing – An Overview

2.1 Introduction

Educational institutions worldwide are undergoing fundamental shifts in how they operate and interact with their customers: students, alumni, donors, faculty members, and staff members. Kotler and FOX state that the best organization in the world will be ineffective if the focus on 'customers is lost. First and foremost is treatment of individual students, alumni, parents, and each other (internal customers). Every contact counts!

During the mid-1980s and the late 1990s, many universities and colleges began to restructuring and reengineering their operations to cut the costs and become more efficient while responding to increased competition. These organizations also realized that developing the in house technology to achieve these goals was expensive, difficult, and time consuming. The many organizations turned to Enterprise Resource Planning (ERP) applications.

These applications helped them automate and optimize their internal business processes in areas such as finance, grants management, student information, enrollment, inventory management, and human resources and freed them from some of the minute details found in day to day operations.

The organizations are now concentrating more on customers. "Higher education customers are demanding more attention and immediate service. Because of the need to concentrate more on customers, many institutions are once again turning to technology this time to Customer Relationship Management (CRM) software. Similar to ERP, CRM solutions focus on automating and improving processes, although the focus is on front office areas, such as recruiting, marketing, customer service, and support. CRM goes several steps further than ERP by helping institutions maximize their customer centric resources".

According to Sheth (1995b), "developing customer relationships has historical antecedents going back into the pre-industrial era. Much of it was due to direct interaction between producers of agricultural products and their customers".

Similarly, artisans often developed customized products for each customer. Such direct interaction led to relational bonding between the producer and the consumer. "It was only after the advent of mass production in the industrial era and the advent of middlemen that interaction between producers and customers became less frequent leading to transaction oriented marketing. In other words, the production and consumption functions became separated leading to the marketing functions being performed by middlemen, and middlemen, in general, are oriented towards economic aspects of buying since the largest cost is often the cost of the goods sold. Thus the impetus of strategizing Customer Relationship Management (CRM), using Internet technology as an enabling tool, escalates as firms strive to deliver value to customers in an intensified competitive market".

According to Jagdish N Sheth and Atul Parvtiyar (2001), the major types of Relationship programmes include the following:

1. Continuity Marketing Programmes these are the programmes that are aimed at both retaining customers and increasing their loyalty. For customers in mass markets, these programmes usually take the shape of membership and loyalty card programmes where customers are often rewarded for their membership and loyalty relationship with marketers
2. One to One Marketing or individual marketing is aimed at meeting and satisfying each customers need uniquely and individual. "By using online information and databases on

individual customer interactions, marketers aim to fulfill the unique needs of each mass market customer".

3. The third type of CRM programme is "partnering relationships between customers and marketers to serve end user needs. In mass markets two types of partnering programmes are most common: co-branding and affinity partnering. In co-branding, two marketers combine their resources and skills to offer advanced products and services to mass-market customers. Affinity partnering programmes are similar to co-branding except that the marketers do not create a new brand, but use endorsement strategies. Usually affinity-partnering programmes try to take advantage of customer memberships in one group for cross-selling other products and services".

Electronic Customer Relationship Management (e-CRM) is a "strategy that analyzes about customers needs and behavior in order to create an effective relationship between an organization and its customers. e-CRM is a combination of hardware and software, process, applications and commitment of management activities to develop high quality customer service, and customers maintenance".

Managing "customer relationship has become one of the most important concerns for an organization. The organizations are seeking for supplementary and effective relationship activities to increase organizational value of customer relationship by improving relationship quality or delivering better relationship benefits. R.A. Feinberg et al (2002) state that Electronic Customer Relationship Management (e-CRM) is an important tool for measuring the performance of an organization in order to help the company to increase its profit and enhance customer loyalty towards the company product".

N.C. Romano Jr. et al (2001) state that "The performance of e-CRM has become a rising alarm in marketing and information technology research and practice. It is a new process that comes from the internet and web technology to make the implementation of e-CRM easy and flexible. The e-CRM concentrates on internet web-based interaction between service providers (organizations) and customers". Samsudin Wahab et al (2011) "The most crucial advantage of CRM and e-CRM is to help the company to identify and categorize customer for enhancing their loyalty and generating profit".

2.2 Customer Relationship Management (CRM)

Customer Relationship Management (CRM) is widely implemented as a tool "for managing a company's interactions with customers, clients and sales prospects. It involves using technology to organize, automate, and synchronize business processes principally sales activities, but also those for marketing, customer service, and technical support. The overall goals are to find, attract, and win new clients, nurture and retain those the company already has, attract former clients back into the fold, and reduce the costs of marketing and client service. Customer relationship management describes a companywide business strategy including customer interface departments as well as other departments. Measuring and valuing customer relationships are critical to implementing this strategy".

CRM is "a strategy used to learn more about customers needs and behaviors in order to develop stronger relationships with them. Good customer relationships are at the heart of business success. There are many technological components to CRM, but thinking about CRM in primarily technological terms is a mistake. The more useful way to think about CRM is as a process that will help bring together lots of pieces of information about customers, sales, marketing effectiveness, responsiveness and market trends".

If "customer relationships are the heart of business success, then CRM is the valve pumps a company's life blood. As such, CRM is best suited to help businesses use people, processes, and technology to gain insight into the behavior and value of customers. This insight allows for improved customer service, increased call center efficiency, improved close rates, streamlined sales and marketing processes, improved customer profiling and targeting, reduced costs, and increased share of customer and overall profitability".

Customer Relationship Management (CRM) "is a term for methodologies, processes, software, and systems that assist an enterprise in managing customer relationships in an organized and effective manner. In this context, the term "customer" can include suppliers, sales leads, employees, as well as paying customers. The goal of CRM is to optimize profitability, revenue, and customer satisfaction by organizing the enterprise's processes toward providing consistent high quality service to the customer". To support these "customer-centric" processes, a set of CRM software and systems is typically implemented which has traditionally supported four main corporate functions:

- Automating and streamlining sales and customer support functions.
- Managing the flow of information in and out of the departments that handle customer transactions.
- Analyzing customer data gathered throughout the enterprise.
- Planning and managing marketing and sales strategies and campaigns.

2.2.1 Relationship Marketing

The "concept of relationship marketing was first coined by Leonard Berry in 1983. He considered it to consist of attracting, maintaining and enhancing customer relationships within organizations. In the years that followed, more and more companies were engaging in a meaningful dialogue with individual customers. In doing so, new organizational forms as well as technologies were used, eventually resulting in what we know as CRM".

In the modern market economy, along with development of computer technology, Internet and database software, key business activities is becoming two-way communication between companies and customers. Managing relationships with the customer, the Customer Relationship Management (CRM) is a relatively new concept which is increasingly developing due to changes in management, strategic business planning and personalized services, to customers.

Development of new Information Technologies (IT) affects changes in business transactions from push to pull strategy specification, and changes in the position of customers in a value chain. Customers are becoming more demanding and sophisticated in their shopping behavior. Hence it is necessary to consider the basic dimensions of customer relationship management which can significantly improve competitive position: Customer selection (identification), Customer acquisition (attraction), Customer retention (holding), Customer growth (maintaining long term relationship).

2.2.2 CRM Concepts

The CRM concept includes capabilities, methodologies and technologies "that enable the company to operate in improved customer relationships. The purpose of CRM is to enable more effective (and efficient) implementation of company goals through a more analytical understanding of real customer needs. CRM focuses on creating and maintaining lasting relationships with customers. Although there are several commercial CRM software packages on the market which support CRM strategy, CRM is not technology per se, but rather a fundamental change in organizational philosophy with emphasis on the consumer".

These software packages with appropriate hardware enable CRM system to become an automated process, with a goal to provide not only information but also to serve as an important support system for decisions making and analyzing market trends. "However, successful CRM strategy cannot be implemented overnight by simple installation and integration of a software package. Changes must occur at all levels, including company policy, employees' training, marketing systems, information management and other. This means that all business aspects must comply with the principles of CRM".

Core of CRM is alignment of business strategy, organizational structure, company culture, customer information and information technology, in order to meet customers needs in all contacts with them and achieve business gains and profits. Business strategy that gives a client the central role is able to provide an answer to a question that many companies often do not know - how many clients they have and which of them are really profitable?

2.2.2.1 Definition of Customer Relationship Management (CRM)

1) The principles, practices, and guidelines that an organization follows when interacting with its customers. "From the organization's point of view, this entire relationship not only encompasses the direct interaction aspect, such as sales and/or service related processes, but also in the forecasting and analysis of customer trends and behaviors, which ultimately serve to enhance the customers overall experience".

2) Customer Relationship Management (CRM) "is a comprehensive strategy and process of acquiring, retaining, and partnering with selective customers to create superior value for the company and the customer. It involves the integration of marketing, sales, customer service, and the supply-chain functions of the organization to achieve greater efficiencies and effectiveness in delivering customer value".

2.2.3 The Role of CRM

The aim of introducing CRM is to optimize customers management lifecycle, increase company profitability, and meet customer needs in order to achieve the highest degree of loyalty. Multi-dimensional vertical and horizontal analysis of information collected during each transaction or interaction (purchase, technical support and other activities), delivers lot of information about customers which will serve a basis for future customer oriented strategy. Thus, CRM should not be viewed only as a technological improvement, but as an informational-technological solution that gives opportunity to create unique customer database and improve it in time. Technology influences principles of communication, and communication influences customer relationships.

Target audience along with customers includes stakeholders and interest groups. For that reason CRM could be viewed as a tool which improves synergic effects of all marketing communications. Implementation of CRM improves competitive advantage, facilitates competition, and opens foreign markets. It also helps anticipate what is necessary to change in order to become a system which will stay along with the needs of increasingly demanding global market. Prerequisites for the creation of anticipative and rational CRM companies are seven skills of customer (customer awareness, entrepreneurial thinking, adaptability, initiative, innovation, cooperation and influence).

CRM strategic framework is interaction of four inter-related functional business processes (Domazet, 2010):

1. Formulation of company strategy (business strategy and customer strategy);
2. Value creation through customer perception and awareness;
3. Integration through multiple channels (multi-channel management which includes sales force, output information, phone and direct marketing, ecommerce, mobile commerce, etc.)
4. Campaign successfulness evaluation through monitoring.

Integrated CRM improve synergic effects of processes to a greater level than each process individually would achieve. The role of CRM is integrative since business processes are viewed as integrated set of activities which provide company growth through:

- Identification, understanding and effectively customer relations
- Targeted sales of existing products and services to new and existing customers,

- Development of new attractive offers, price discounts and marketing programmes for customer,
- Retention and sharing of profit with the most profitable customers.

According to Llamas-Alonso et al (2009): the effects CRM implementation may be multiple, more effective segmentation of target groups,

- Analytical forecasting of market trends,
- Faster response to market changes,
- Profitability analysis of individual customers,
- Ability to direct sales to highly profitable customers,
- Improved quality of services and sales opportunities,
- Longer customer retention,
- Shorter sales cycles and higher profitability of the sale process,
- Synchronization and analysis of information gathered from various sources,
- Improved efficiency and flexibility of operations,
- Intensive development of competitive advantage and company reputation as a strong business partner.

The basic requirements for successful implementation of CRM are: a good knowledge of business and competition; knowledge of end customers, a market way of thinking, synchronized company behavior, Payne A, Frow P. (2005) state that "an integrated approach to managing channels of communication, sales, and database development. These assumptions form the basis of a conceptual framework for developing a strategy CRM strategy".

2.2.4 CRM Value Chain

Customer relationship management as a process that includes: "defining value, segmentation, targeting and positioning, operations and delivery systems, measurement and feedback, external and internal market" which is shown in figure 6.

INTERNAL MARKET MANAGEMENT (Internal planning of marketing, culture, climate and employee loyalty)		
Segmentation, targeting and positioning * customer preferences identification * sectorial profitability analysis * creation of package values	Business operations systems and delivery * mass adapting * partnership * process reengineering	Measuring and feedback * process review and consultancy * customer satisfaction studies on products/services * employee satisfaction studies
EXTERNAL MARKET MANAGEMENT (External planning of marketing, CRM)		

Figure 1 : CRM chain

Source: Adapted from Lovreta et al (2010)

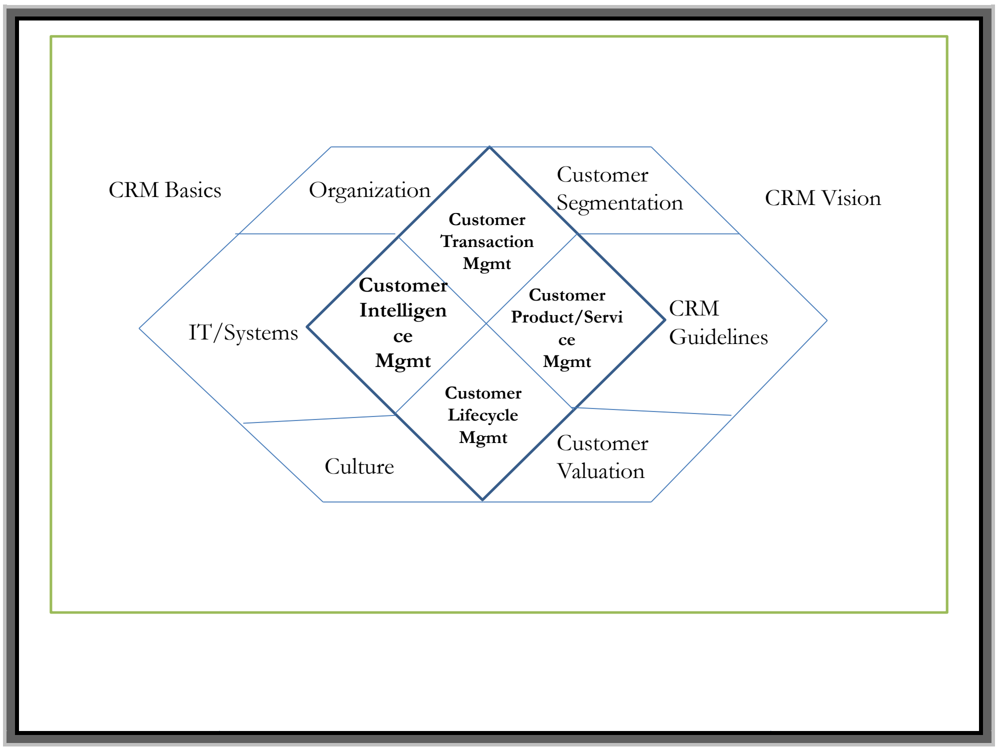


Figure 2 : CRM diamond

Source: Adapted from Mack O, Mayo M i Khare A. (2005)

This strategic approach to organizational design is explained by Mack et al (2005) “where they organized elements of a successful CRM strategy into a Diamond framework as presented in Figure 7. It focuses on vision, activities and basic business activities as key factors of successful implementation of CRM in a business environment”.

Finally when compiling the above, Buttle (2001) presented “The CRM value chain (Figure 8) as a proven model which businesses can follow when developing and implementing their CRM strategy. The model is grounded on strong theoretical principles and the practical requirements of business”.

The “ultimate purpose of the CRM value chain process is to ensure that the company builds long term mutually beneficial relationships with its strategically significant customers. Not all customers are strategically significant. Indeed some customers are simply too expensive to acquire and service. They buy less quantity and less frequently; they pay late or default; they make extraordinary demands on customer service and sales resources; they demand expensive, short-run, customized output; and then they defect to competitors”.

“CRM value chain indicates to primary and secondary activities in building long term relationships with customers, in order to achieve higher level of their satisfaction as the basis for long-term loyalty”.

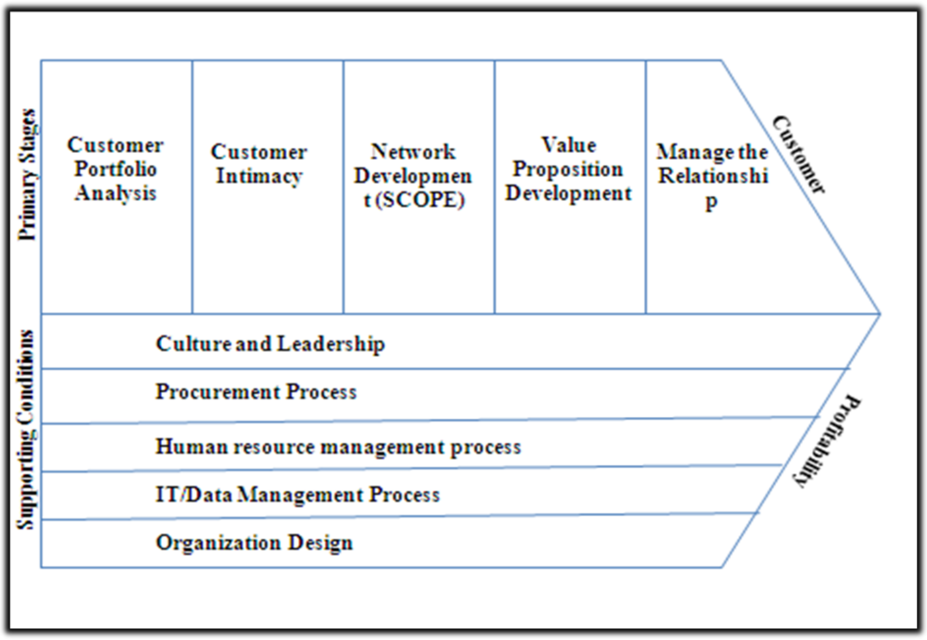


Figure 3 : CRM Value Chain

Source: Buttle F (2001)

The CRM value chain includes the five primary activities:

1. Consumer Portfolio analysis - "an analysis of the customer database aiming to offer different products to them".
2. Understanding the customers: "activities on understanding individual or groups of customers and building database accessible to all stakeholders whose decisions and activities may affect the attitudes and behavior of customers".
3. Networking: "building a strong network of relationships with employees, suppliers, partners and investors who understand the requirements of target customers. Central role in the model is given to customers, which is surrounded by other elements: suppliers, owners, investors, employees, and other partners. Management and coordination, according to these elements, can ensure the structuring, communication and delivery of preferred products to customers".

4. Development of products/services value: “development of proposals which create value for both customers and the company”.
5. Managing relationships with customers: “with a focus on structures and processes. Supporting activities are aiming at: culture and leadership, procurement processes, Human Resources, data management process and company organizational design”.

2.2.5 Prerequisites for CRM Implementation

There are “different approaches to defining what necessary elements are for CRM strategy to be successfully implemented. According to Zubović, Bradić Martinović and Džopalić (2010) requirements for creation of high quality CRM models are:”

- Customers satisfaction and loyalty.
- Data protection.
- Business intelligence tools.
- Enterprise resource planning.
- Creation of integrated business systems.

2.2.5.1 Satisfaction, loyalty and creation of long-term value for customers

Customer satisfaction can be defined as a "customer response to the assessment of perceived differences between expectations and actual product performance, as he saw them after purchase (Veljković 2009). Satisfaction is required for continued cooperation between customer and company and it is the main, but not the only prerequisite for existence of loyalty. Customer satisfaction is the key to retain existing and attract new customers.

Companies have to trace customer response to their offer, no matter if it is positive or negative. If customers are satisfied and the preference is expressed through re-purchase of products/services over the long term, we can talk about loyalty. The buyer who is loyal in addition to buying our product is spreading positive promotion and helps the company to attract new customers. An important role in creation of loyalty plays customers trust and commitment to company brands. It is important to note that loyal customers for company are at the same time lost customers to its competitors. The traditional approach to marketing focused more on sales than on development of long term relationship with customers. If focus of attention is on what happens after sale, on how customers see and use company's products/services and on how satisfied and loyal they are, company can create loyal customers and keep existing ones at the same time with successful and profitable business activities.

Value of customers for company is defined by the concept of Customer Lifetime Value – (CLV). It represents a net present value of future profits expected from customers purchases during his lifetime. By applying the appropriate discount rate we can estimate "gross" lifetime value. From that amount we should deduct the sum of the expected costs of attracting customers, customer retention expenses, sales costs and expenses of serving the customer and thus obtain a net profit realized from a customer in a lifetime.

2.2.5.2 Privacy protection as the basis for customer confidence

Personalized CRM is based on the principle that each customer should be treated separately. It refers to each physical person who buys products for personal consumption as well as to all companies which purchase products to create their own products/services (for further reproduction). For that principle to be implemented successfully it is necessary to gather data about each customer, load it into information system, process it and store so as to create a model which can provide desired information about customers. In order to facilitate the customers to be willing to give information we need from them, they must be sure that their privacy is protected from abuse.

Companies should devote great efforts to show their customers that they understand the problem of privacy. For, it is important to inform each customer, preferably in written form about the attitudes towards protection of privacy, about how collected data will be used and to ensure that none of the data will be shared with third parties. Confidentiality and privacy as the elements of information security policy in business intelligence systems can be achieved by information security policies and procedures, encryption and security tools (Vujović 2005).

In developed countries security of data, information systems and telecommunications became one of the priority tasks of legal systems. As the information technology is developing so is the security issue transferred from national to international. International organizations and associations are slowly dealing with these problems, and in certain cases they form special teams to monitor and address growing risks and opportunities brought out by new technologies.

Some of the issues (data protection, privacy, etc.,) are found in the Universal Declaration of Human Rights, European Convention on Human Rights, the Universal Postal Convention, the

International Convention on Telecommunications, and so on. This has created a framework to adapt laws to the needs, changes and demands of modern information development in the international level (Drakulić 1996).

The growing need for information and fear from their abuse has led to the necessity of its special treatment. Technical capacity of storage, processing, transmission and use of data are all larger. Number of users of data is continuously growing, as well as the number of entities about which and from which data is collected. Expansion of IT technology has imposed the necessity of applying different methods to ensure safety of data. Internet as a specific electronic media, offers technologically new approach to business activities, which requires innovation in legal regulation. Widespread use of e-commerce created a need to regulate basic concepts, procedures, messages integrity, authenticity of signatures, security of operations and a many other issues. Regulation of electronic signatures, quality of products and services, customer protection and intellectual property, and the fight against computer crime are some of the issues to be covered by changes in legal system.

2.3 Electronic Customer Relationship Management – (e-CRM)

The main function of "CRM when seen in the context of e-business or transactions over an electronic medium, it translates in to e-CRM, which essentially deals with managing customer interactions over the web".

It is basically the electronically delivered or managed subset of CRM, managing relationships with customers making use of Information Technology (IT).

In the world, a company can manage to keep its customers happy.

- Building a customer environment and using other means to customer attention have now become the top priorities for any company that wants to make it big in the market.
- As technology changes, more people all over the world have started buying and selling activities over the Internet.

- As a consequence companies also have to give customers a good in easy online environment.
- The result is nothing but e-CRM.

2.3.1 e-CRM concept

The e-CRM concept is derived from E-commerce. It also uses net environment i.e., intranet, extranet and Internet. “Electronic CRM concerns all forms of managing relationships with customers making use of Information Technology (IT). e-CRM is enterprises using IT to integrate internal organization resources and external marketing strategies to understand and fulfill their customers needs. Comparing with traditional CRM, the integrated information for e-CRM intra-organizational collaboration can be more efficient to communicate with customers.”

Globalization and technology improvements have exposed companies to a situation with tough competition. “In this new era companies are focusing on managing customer relationships in order to efficiently maximize revenues. Alvandi and Mirzaei sarv kalaei, 2008 One of the major improvements in the today’s businesses is increasing the profits and productivities which result by customers satisfaction”.

So “if business units focus on the new customers then they can be able more to maintain them. In other words, a business that does not meet its customer expectations or does not have permanent and dynamic long-term relationships with them, in the long term will fade away from the global competitiveness. In the current era, the interactions between organizations have changed. In the past, how to interact with customers was examined in the form of the concept of "customer relationship management". But today, IT has a great impact on the different parts of an organization, especially in the way of interacting with their customers so that the IT tools are used extensively in the customer relationship management leading to emergence of a new concept called "electronic customer relationship management" (Sophonthummapharn, 2009)”.

According to Romano and Fjermestad (2003) “e-CRM concerns attracting and keeping economically valuable customers and repelling and eliminating economically invaluable ones”. e-CRM will continue to develop as an important area of study in MIS and such relevant referent disciplines as computer science, marketing and psychology.

The e-CRM, is principally emerged from CRM, but emphasizes more on personalization, direct marketing technologies for selling and providing distinct services to small parts of the market. Dimitriadis and Stevens, 2008 The e-CRM provides the kind of opportunities to reveal his/her potentials as a customer through establishing an effective relationship with the company, in order to both the company and customer benefit from this relationship.

2.3.2 Definition

The e-CRM provides companies with a means to conduct interactive, personalized and relevant communications with customers across both electronic and traditional channels. It utilizes a complete view of the customer to make decisions about the following.

- Messaging
- Promotional offers, and
- Channel delivery.

It synchronizes communications across otherwise disjointed customer-facing systems. It asks for the permission of the potential customer before talking to him about product or services. It focuses on understanding how the economics of customer relationships affect the business CRM strategy along with its electronic component constitutes e-CRM. The trust of e-CRM is not what an organization is doing on the web but how fully an organization ties its online channel back to its traditional channel or customer touch points.

2.3.3 Need of e-CRM

(i) The CRM offerings remain channel centric not customer centric.

(ii) Contemporary customers facing traditional systems.

(iii) Customer centric metrics is non-existence.

The CRM offerings remain channel centric rather customer centric

CRM focus in improving the effectiveness of the individual channel that their systems support. While this is a necessary step, it does not address the fundamental question of which customers should be targeted in the channel and how much should be invoked in them.

Customer centric metrics do not exist

CRM offerings have weak metrics and measurement capabilities. Generally those with customer profitability return on investment of customer interaction and lifetime value of a customer because data needed for this falls outside the reach and design of channel centric system. Instead they focus on operational metrics such as wait time on calls, the number of annoyed callers. While these metrics are important to run various channels operationally, they fail to address the question. Are we investing the right amount of resource on customers with the most value? Answering the question requires a holistic view of customer experience.

Customer systems of nonintegrated information

Contemporary customers facing traditional systems such as sales force automation and customer care often have their own data models and data stores that manage only the information that their application requires and generates. These systems rarely interact with others, as they remain isolated.

2.3.4 Framework of e-CRM

The era of e-commerce and e-business has given a new lease of life to business processes, where customer need not to meet the seller, but the products and services are sold and purchased online. The organizations have invested a large amount for automation and more over the invention of internet has drastically changed the concept of marketing.

Companies need to take firm initiatives on the e-CRM frontier to:

- Optimize the value of interactive relationship e-CRM must address customer optimization along three dimensions. The three dimensions are:

  (i) Acquisition: increasing the number of customers.

  (ii) Expansion: increasing probability by encouraging customer to purchase more products and services.

  (iii) Retention: increasing the amount of time that customer stays.

- Enable the business to extend its personalized reach.
- Coordinate marketing initiatives across are the customer channels.
- Leverage customer information for more effective e-marketing and e-business.

2.3.5 Key Features of e-CRM

e-CRM implies capabilities like self-service knowledge bases, automated email response, personalization of web content, online product bundling and pricing.

- e-CRM gives Internet users the ability to interact with the business through their preferred communication channel.
- It allows business to offset expensive customer service agents with technology.

- e-CRM focus on the customer satisfaction and reduced cost through improved efficiency.
- e-CRM use customer data for personalization, cross-selling and up-selling.
- Sales Force Automation (SFA) and Enterprise Marketing Automation (EMA) is integrated in the e-CRM.

- Driven by a data warehouse.
- Focused on consistent metrics to assess customer actions across channels.
- Built to accommodate the new market dynamics that place the customer in control.
- Structured to identify a customers profitability and to determine effective investment allocation decisions accordingly, so that most profitable customer could be identified and retained.

Benefits of e-CRM: "A fundamental motivator is the speed and unparalleled cost effectiveness of the Internet is making the implementation of e-business possible and relatively cost-effective".

1. The Internet as a service-delivery channel, the customers find better information through websites. "Thus high level of customer control that translates into customer satisfaction and repeat purchase is the most critical advantage of e-CRM".

2. Other related benefits "include decreased cost of sales and promotion, high supply-chain management integration and improved logistics management. Companies have tied up with service providers in telecom and power sectors and cellular service providers for allowing their customers to make bill payments online. In

India, new private sector banks like ICICI Bank, HDFC Bank, Global Trust Bank and UTI Bank, have taken the lead in e-banking. Even the state run banks like SBI and Union Bank of India have realized the advantages of such techniques".

2.4 High Performance Computing (HPC)

2.4.1 Research and Development

While computer performance has improved dramatically, real productivity in terms of the science accomplished with these ever faster machines has not kept pace. Indeed, scientists are finding it increasingly costly and time consuming to write, port, or rewrite their software to take advantage of the new hardware. "While machine performance remains a critical productivity driver for high performance computing applications, software development time increasingly dominates hardware speed as the primary productivity bottleneck. Traditional benchmark does provide a way to measure productivity. Removing or ameliorating productivity bottlenecks in next generation high performance computing systems is a key objective of DARPA's High Productivity Computing Systems (HPCS) Program. This objective has characterized as the long-term goal of improving software productive at a rate commensurate with improvements in the underlying hardware".

Stating the goal this way reflects the scientific community's experience that "improved hardware performance often does not yield similar improvements in important measures like total cost, effort, or time to solution. Addressing these larger productivity issues will require addressing productivity bottlenecks in software development, project management, and system administration in addition to hardware performance".

Research and Development in electronic and high performance computing is likely to grow faster as compared to domestic ICT R and D. "Outsourcing of R and D is largely dependent on network, 25 years ago supercomputers were used by a small and rarified group of experts primarily physicists, researchers at weapons laboratories, and cryptographers. This began to change within the US in the 1980s when government initiated the Advanced Scientific Computing Centers program and created five nationally shared supercomputer centers. These centers were given a mandate to provide access to supercomputer resources to scientists across the US. Still, the community making use of supercomputers or high performance computing (HPC) systems as they are now more generally known remained quite small, and was dominated by applications in physics and astronomy".

Today supercomputers are used in an increasingly diverse array of sciences as well as the arts. The use of "parallel programming techniques the application of many processors to a single problem simultaneously is of fundamental importance to the advancement of knowledge and solution of some of the most important problems facing humankind today. Understanding the function of the human genetic sequence, creating new art forms based on virtual reality, and accurately modeling atmospheric change are enabled in unique ways by the application of parallel programming techniques. Parallel programming techniques are necessary to solve problems that would otherwise require impossibly long times if solved with uniprocessor, serial programming techniques. Parallel computing techniques are important in pushing back the boundaries of capability computing, the solution of the largest problems in simulation and analysis. Parallel computing techniques are also used in capacity computing, for example, analyzing the behavior of a function over a very large parameter space by calculating the value of a function at a very large number of points".

2.4.1.1 Parallel Processing

HPC is the use of parallel processing for running advanced application programmes efficiently, reliably and quickly. "The term applies especially to systems that function above a teraflop or 10 floating-point operations per second. The term HPC is occasionally used as a synonym for supercomputing, although technically a supercomputer is a system that performs at or near the currently highest operational rate for computers. Some supercomputers work at more than a peta flop or 10 floating point operations per second".

The "common users of HPC systems are scientific researchers, engineers and academic institutions. Some government agencies, particularly the military, also rely on HPC for complex applications. High performance systems often use custom made components in addition to so called commodity components. As demand for processing power and speed grows, HPC will likely Internet businesses of all sizes, particularly for transaction processing and data warehouse". An occasional techno fiend might use an HPC system to satisfy an exceptional desire for advanced technology.

2.4.1.2 Supercomputer

A supercomputer would automatically think of as monstrously a complicated machines to solving problems no one really understands. May be they think of flashing lights and some super intelligence that can beat humans at chess or figure out the meaning of life, the universe, and everything.

Supercomputers was used "by the scientists and engineers, who needed for number crunching as fast as possible. Present day we have a different world. The customized supercomputer of yesteryear has given way to commodity based supercomputing, or it is now called High Performance Computing (HPC). In present day HPC world, it is not uncommon for the supercomputers to use the same hardware found in Web servers and even desktop workstations. The HPC world is now open to almost everyone because the cost of entry is at an all-time low".

Scientific computing "is the inter-disciplinary field at the intersection of modeling scientific processes, and the use of computers to produce quantitative results from these models. It is what takes a domain science and turns it into a computational activity. As a definition, we may posit. The efficient computation of constructive methods in applied mathematics".

It is clearly indicates that the three branches of science that scientific computing touches on:

- Applied mathematics: "the mathematical modeling of a real world phenomena. Such modeling often leads to implicit descriptions, for instance in the form of partial differential equations. In order to obtain actual tangible results, we need a constructive approach".
- Numerical analysis "provides algorithmic thinking about scientific models. It offers a constructive approach to solving the implicit models, with an analysis of cost and stability".
- Computing takes "numerical algorithms and analyzes the efficiency of implementing them on actually existing, rather than hypothetical, computing engines".

One might say "that 'computing' became a scientific field in its own right, when the mathematics of a real world phenomena was asked to be constructive, that is, to go from proving the existence of solutions to actually obtaining them. At this point, algorithms become an object of study themselves, rather than a mere tool".

The study of "algorithms became especially important when computers were invented. Since mathematical operations now were endowed with a definable time cost, complexity of algorithms' became a field of study; since computing was no longer performed in 'real' numbers but in representations in finite bit strings, the accuracy of algorithms needed to be studied. Some of these considerations in fact predate the existence of computers, having been inspired by computing with mechanical calculators".

A prime concern in scientific computing is efficiency. "While to some scientists the abstract fact of the existence of a solution is enough, in computing we actually want that solution, and preferably yesterday". It is important not to limit the concept of efficiency to that of efficient use of hardware. While this is important, the difference between two algorithmic approaches can make optimization for specific hardware a secondary concern.

The many organizations are now considering the HPC as an essential part of business success. Using HPC, "the organizations are designing new products, optimizing manufacturing and delivery processes, solving production problems, mining data, and simulating all the functions from business process to shipping crates, all in an effort to become more competitive, profitable, and "green." HPC may become very well be the new secret weapon in business success also".
Currently, there are four modes of supercomputing environments' in which you can obtain the cycles needed for typical HPC problems:

2.4.1.3 The commodity HPC cluster

In the last decade, "the HPC cluster has disrupted the entire supercomputing market. Built from standard off-the-shelf servers and high speed interconnects, a typical HPC system can deliver industry leading, cost effective performance. A typical cluster can employ hundreds, thousands, and even more than tens of thousands of servers all working together on a single problem (this is the high tech equivalent of a "divide and conquer" approach to solving large problems). Because of high performance and low cost, the commodity cluster is by far the most popular form of HPC computing".

2.4.1.4 Dedicated supercomputer

The dedicated "supercomputer was the only way to throw a large number of compute cycles for a problem. Supercomputers are still produced today and often used for specialized non-commodity components. Depending on your needs, the supercomputer may be the best solution although it doesn't offer the commodity price advantage".

2.4.1.5 HPC cloud computing

This method is relatively new and employs "the Internet for a cycles-as-a-service model of computing. The compute cycles in question live in the cloud somewhere allowing a user to request remote access to cycle's on-demand. An HPC cloud provides dynamic and scalable resources (and possibly virtualization) to the end-user as a service. Although clouds can be cost effective and allow HPC to be purchased as an expense and not a capital asset, it also places some layers between the user and hardware that may reduce performance".

2.4.1.6 Grid computing

Grid is similar to cloud computing, but requires more control by the end-user. Its main use is academic projects where local HPC clusters are connected and shared on a national and international level. Some computational grids span the globe while others are located within a single organization.

2.4.1.7 HPC Applications

The HPC applications are available to many industrial, government, and academic sectors. The following is a list of major areas where HPC has a significant presence:

Bio-sciences and the human genome: Drug discovery, disease detection/prevention.

Computer Aided Engineering (CAE): Automotive design and testing, transportation, structural, mechanical design.

Chemical Engineering: Process and molecular design.

Digital Content Creation (DCC) and distribution: Computer aided graphics in film and media.

Economics/Financial: risk analysis, portfolio management, automated trading.

Electronic Design and Automation (EDA): Electronic component design and verification.

Geosciences and geo-engineering: Oil and gas exploration and reservoir modeling

Mechanical Design and Drafting: 2D and 3D design and verification, mechanical modeling.

Defense and Energy: Nuclear stewardship, basic and applied research.

Government Labs: Basic and applied research.

University/Academic: Basic and applied research.

Weather Forecasting: Near term and climate/earth modeling.

The list could be longer as more and more areas are finding HPC useful as a tool to better understand their science, market, products, and customers. As pioneers, the government and academic sectors have been successfully using and validating HPC methods for well over a decade.

2.4.2 HPC Resources in INDIA

2.4.2.1 Computing Facilities

India's research in using computing systems for scientific calculation started way back in the 1960's. Indian researchers used some of early mainframes available at select institutions in the country. The IBM 1620 and IBM 7044 (at the Indian Institute of Technology, Kanpur), the IBM 1401 (at the Indian Statistical Institute, Kolkata), the CDC 3600 (at the Tata Institute of Fundamental Research, Mumbai), and the IBM 360/44 (at the Indian Institute of Science, Bengaluru) were some of the early mainframe systems.

Subsequently other mainframes such as the IBM 370/165 (at the Indian Institute of Technology, Chennai), the DEC 1077 (at the Tata Institute of Fundamental Research, m) and the Mumbai DEC 1090 systems (at the Indian Institute of Science, Bengaluru and the Indian Institute of Technology, Kanpur) were installed and used extensively by researchers in 1970's.

Computing applications were mainly in the areas of finite element analysis, computational fluid dynamics, protein structure, power system analysis, and structural chemistry and solid state physics.

Simultaneously research and graduate programmes in computer science started in India in mid-1960s. Research groups grew at the Tata Institute of Fundamental Research, Mumbai, the Indian Institute of Science, Bengaluru, the five Indian Institutes of Technology, Indian Statistical Institute, Kolkata, Jadavpur University, and the Birla Institute of Technology and Science, for example. Early focus was on numerical computing, theory of algorithms, complexity, program verification and formal techniques for programming, systems software and programming, and artificial intelligence.

Research in high performance computing started in India in the mid 1980's. Several academic institutions /research organizations aspired to acquire supercomputing systems in order to meet the demands of their computational scientists/engineers. At the Indian Institute of Science, Bengaluru, an initiative to set up a national supercomputing facility was started by the Department of Electronics and Ministry of Human Resource Development, Government of India in mid-1980s.

This fructified as the Supercomputer Education and Research Center (SERC) which hosts a number of high performance computing systems in the country. Disheartened by delays in procuring a Cray XMP system, SERC hosted a Cyber 992 system and a VAX 8800 system in the late 1980's and early 1990's. Also, SERC set up one of the first workstation farm of IBM headless workstations connected by a network. SERC also deployed a PARAM 8000 machine, indigenously developed in India by the Center for Development of Advanced Computing (C-DAC). By 1993/94, SERC hosted a variety of distributed high performance computing systems such as IBM's 32-node Scalable Parallel (SP) system, SGI's 6-processor Power Challenge system as well as an 8-processor DEC-8400 system in addition to a large number of IBM and Sun workstations.

Around the same time, a national initiative in supercomputing in the form of a time bound mission to design, develop, and deliver a supercomputer in the Gigaflop range was launched. This fueled HPC systems research in research organizations (outside an academic institution). Organizations such as Center for Development of Advanced Computing (C-DAC), Center for the Develop of

Telematics (C-DoT), Bhaba Atomic Research Center (BARC), Advanced Numerical Research Group (ANURAG), and National Aerospace Laboratories (NAL) initiated several complementary projects to develop high performance computing systems. While C-DAC came us with the first indigenous supercomputing system, called PARAM 8000 series, which used in 800 and 805 Transputers to achieve a theoretic peak performance of 1 Gigaflop. The sustained speedup achieved was 100-200 Mega FLOPS. Other research organizations joined the race with parallel systems ranging from 8-nodes to 64-nodes have been designed and developed independently.

India's first Top500 system came from CDAC, Bengalure, in June 2003 with the Param Padma supercomputer. It featured in the Top500, listed at 169th rank. "It is the first supercomputer to find place in the Top500 list which is indigenously designed, developed and commissioned in India. It used a cluster of 62 4-way, IBM pSeries P630 nodes interconnected through a high performance System Area Network, PARAMNet-II, designed and developed by C-DAC" and achieved a sustained performance of 532 Gigaflops'.

Another supercomputing development at an academic environment was carried out at the Institute of Mathematical Sciences, Chennai (IMSC). This Linux cluster, named Kabru, with 144 nodes (Intel Dual Xeon 2.4 GHz) interconnected by Dolphin 3D SCI network. The cluster achieved a sustained performance of 959 Gigaflops' and was ranked 264 in the June 2004 Top500 list. This was the first Top500 system from an academic institution in India.

The system was built to perform large scale numerical simulations in the area of Lattice Gauge Theory. Eka (the Sanskrit name for number one), developed by Computational Research Laboratories (CRL), Pune, with technical assistance and hardware provided by Hewlett-Packard, was the first to break into the top 10 ranking in the Nov. 2007 Top500 list. This system has 1780 computing nodes (3560 Intel Quad Core Xeon 3GHz) interconnected by a CLOS network with Infiniband interconnect technologies. It achieved a sustained performance of 132.8 Teraflops and was ranked 4th in the Top500 list (Nov. 2007).

In the last 5 years a number of (10 to 15) high performance computing systems have been developed/acquired with performance ranging from 4 Teraflops to 20 Teraflops at various academic institutes (mostly clusters). More importantly there are a large number of smaller clusters with performance ranging from 500 Gigaflops' to 1 Teraflops which are used for developing high performance application in various disciplines in science and engineering.

2.4.2.2 Computer Systems Research in India

India's first effort in building a large digital computer started way back in 1954, when a team of scientists at the Tata Institute of Fundamental Research, Bombay, embarked on the design of TIFRAC (TIFR Automatic Calculator). It was fashioned on the general principles enunciated in the classic Von Neumann report. The basic components of this system were the arithmetic unit, the memory unit, the input-output unit, and of course, the control unit. TIFRAC used an innovative carry bypass adder, textual and graphical output on a visual display on a CRT screen, and 1024 words of the then relatively new ferrite core memory. When completed in 1960, TIFRAC had 2700 vacuum tubes, 1700 germanium diodes and consumed a total power of 18 Kilowatt. TIFRAC also resulted in the first attempts at system programming in India.

In 1966, the country took a quantum leap as the second-generation computer, first transistor-driven computer, was indigenously developed. The computer was the product of a joint venture between the scientists of the Indian Statistical Institute, Calcutta, and those of Jadavpur University and was fondly nicknamed `ISIJU'.

Academic research in mid 1980s focused on Fifth Generation Systems which resulted in several research efforts on dataflow computing systems. Research work on Knowledge Based Computer Systems (KBCS) project, funded by Department of Electronics with the assistance of the United Nations Development Program (UNDP), focused on parallel processing, including parallel processing machines, logic programming environments, and the engineering of parallel AI workstations.

The national initiative to design, develop, and deliver a supercomputer and the founding of the C-DAC in the late 1980's, triggered a series of research efforts in building supercomputing systems. Other research organizations such as C-DoT, BARC, ANURAG, and NAL were involved in the design of parallel computer systems and associated software. These efforts resulted in a series of parallel systems during the 1990s. C-DAC's sustained efforts fructified as a series of PARAM systems (PARAM 10000, PARAM Padma, and more recently the PARAM Yuva). In addition to development of this system, CDAC also developed the software stack for the PARAM systems and developed the PARAMNet-II interconnection network, which is a significant HPC system design and development work in India.

2.4.2.3 High Performance Centers and Facilities

The **Computational and Research Lab (CRL)**, Pune, a wholly owned subsidiary of Tata Sons Limited (a group holding company), has been specially set up to achieve global leadership in the field of High Performance Computing (HPC). CRL's interests include computer system architecture, parallel system design, parallel systems software, hardware design and interconnection networks, parallel scientific, engineering, digital media, communication and business analytics software libraries and applications. CRL hosts the fastest the HPC system in India, called EKA, currently ranked at No. 13 (Nov. 2008 list) with a sustained performance of 132.8 Teraflops and a peak performance of 172.6 Teraflops.

It uses infiniband interconnect technology and supports a parallel cluster file system for data storage. It was the fastest system in Asia and 4^{th} fastest system in the November 2007 Top500 list. The system is extensively used for various Computational Fluid Dynamic applications, graphics animation, and weather and climate modeling applications. The HPC system research focus of

CRL has been on the development of Interconnect systems based on Infiniband hardware and the development of FPGA based accelerators for various integer applications. CRL is also working on system level network topology simulation tools for study of future large system behavior.

Figure 4 : CRL – Pune
EKA Supercomputer in CRL, Pune

The **Center for Development of Advanced Computing (C-DAC)**, established in March 1988, as a Scientific Society of the Department of Information Technology (formerly, Dept. of Electronics), Ministry of Communications and Information Technology (formerly, Ministry of Information Technology), Government of India, is primarily an R and D institution involved in the design, development and deployment of advanced Information Technology (IT) based solutions. CDAC is engaged in the design, development and deployment of High Performance Computing (HPC) Systems and Solutions.

Over the past two decades, C-DAC has delivered a series of PARAM supercomputers and has built national capabilities to make use of supercomputing technologies for human enrichment. The

National Param Supercomputer Facility at Pune and Tera Scale Supercomputer Facility at Bengaluru are CDAC's primary HPC centers. CDAC's Param Padma in 2003 was one of the first Indian systems to enter Top 500, a periodically updated list that maintains the list of top supercomputers of the world. PARAM Yuva is a latest addition to the PARAM series. This system with 288 nodes, sustained performance of 37.80 TFs and peak performance of 54.01 TFs has ranked 68th in the coveted list of Top500 supercomputers of the world and is the 2nd powerful system in India according to Top Supercomputers-India. Para Yuva uses several indigenously designed system components including ParamNet System Area Network, accelerator cards, application and system software suite.

Figure 5 : Param YUVA in CDAC, Pune

The C-DAC Bengaluru, houses the Param Padma Teraflop cluster, the first Top500 system from India, which is a 248 CPU cluster with IBM Power 4 processors. As a part of the Grid initiative, the Center augmented the Param Padma with a Teraflop of computing power with an additional

168 cores of IBM Power 5 processors. More recently the Center has added a 4 Teraflops (peak performance) 320-core Intel Xeon based cluster to its computational facility.

Figure 6 : Param PADMA in CDAC, Bengaluru

The **Center for Modelling, Simulation and Design (CMSD)**, at University of Hyderabad, approved by University Grants Commission (UGC), is established with the support of Department of Science and Technology (DST) under its FIST (Fund for Improvement of S and T Infrastructure in Higher Educational Institutions) programme. CMSD is a state-of-the-art High Performance Computing (HPC) center and focuses on computer based simulations of scientific applications and realizes the importance of scientific research, based on modeling, simulation and design.

The Center for Modelling, Simulation and Design (CMSD), University of Hyderabad, has a Currently, "CMSD has a 25.0 Teraflop Facility consisting of 6 SMP systems, SGI Altix 4700 a 128 core (Dual Core, Itanium2 9150M 1.67 GHz) shared memory architecture based Unix server comprising of 512 GB RAM, SGI Altix ICE 8200 EX Cluster (Enhanced) with 1024 core high performance, high throughput and high availability cluster comprising of 1 GB/core memory, built using Infiniband Interconnect. SGI XE1300, 2 x Quad core @ 3.0GHz, 4 GB RAM, 146 GB HDD. A 128 core Windows CCS/HPC Cluster. SGI IS4600 x 2, 100 Terabytes' of shared Storage system (FC, SATA) for delivering very demanding data intensive environment, leading to High Performance and Productive Computing Facility, through SGI Altix 450 x 2, 8 core, 48 GB RAM, Montvale 1.67 MHz storage servers. a CDAC Param cluster with 16 nodes".

Figure 7 : HPC Systems at University of Hyderabad

Indian National Center for Ocean Information Services (INCOIS) is an autonomous organization under Ministry of Earth Sciences (MoES), Government of India. "The mission of INCOIS is to provide information and advisory services to society, industry, government agencies and scientific community through sustained ocean observations and constant improvements through systematic and focused research". INCOIS is involved in various activities including implementing potential fishing zone advisories, developing and maintaining Argo profiling floats for measurement of temperature and salinity through the upper 2000 meters of the open Indian Ocean in real time, and R and D in area of ocean-atmosphere modeling focusing on the ocean predictability and climate variability.

It is also the organization responsible for providing early warning for tsunami and storm surges. "INCOIS was designated as the National Oceanographic Data Center under the International

Oceanographic Data Exchange programme of the Intergovernmental Oceanographic Commission of UNESCO". Indian National Center for Ocean Information Services (INCOIS) possesses an 80 processor SGI cluster and a 100 Terabytes storage system to meet its specific requirements of running coastal, regional and global/regional ocean models in operational, data assimilation and other future computational requirements for handling large amounts of data.

The **Tata Institute of Fundamental Research (TIFR)**, is an autonomous Institute established in 1945 under the umbrella of the Department of Atomic Energy of the Government of India. TIFR does basic research in physics, chemistry, biology, and mathematics and computer science. TIFR has campuses in Mumbai, Pune and Bengaluru and research facilities in various other places in India. TIFR was one of the few academic institutions to host a computer system in the early 1960s.

TIFR is also known for its pioneering work in developing the first indigenous computing system using vacuum tubes, called TIFRAC. The computer center at TIFR, Mumbai, presently hosts a CRAY X1 (acquired in 2004) and a Blue Gene P (acquired later in 2008). The Cray has 16 vector processors, each 12.8 GFLOPS (total of nearly 200 Gigaflops'). The Blue Gene/P has 1024 processors (4096 cores) which achieved a sustained performance of 11.32 Teraflops' on HP Linpack code. Major HPC applications include Quantum chromodynamics, quantum field theory, condensed matter and statistical physics.

Supercomputing Facility for Bioinformatics and Computational Biology (SCFBIO) a HPC center at Indian Institute of Technology (IIT) Delhi. Its mission is to develop highly efficient algorithms for genome analysis, protein structure prediction and active site directed drug design. The facility is committed towards providing bioinformatics and computational biology tools and software freely accessible to bioinformatics community. SCFBIO possesses a 104 core AMD Opteron cluster and a 70 core Sun Fire Ultra Sparc III cluster with a 4 Terabytes' SAN storage system and a combined performance of 0.7 Teraflops'. It will soon install a 600 core AMD

Opteron cluster with 12 Terabytes' of Direct Attached Storage (DAS) for storing the data, and a combined performance of 4 Teraflops'.

Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR) is located in the north of Bengaluru. The **Center for Computational Materials Science (CCMS)** is a unit of JNCASR. CCMS, JNCASR, has a 512 core HP ProLiant cluster with 32 Terabytes' aggregate storage capacities. The cluster is ranked 8th in the latest list of Top Supercomputers-India.

The **National Center for Biological Sciences (NCBS)**, Bengaluru, is part of the "Tata Institute of Fundamental Research and is located in Bengaluru. The mandate of NCBS is basic research in the frontier areas of biology". The research interests of the faculty are in four broad areas ranging from the study of single molecules to systems biology. NCBS possesses 3 AMD Opteron based clusters with a total of 420 cores.

Supercomputer Education and Research Center (SERC) is a department in Indian Institute of Science, Bengaluru. "It is conceived of as a functionally distributed supercomputing environment, housing leading-edge computing systems, with sophisticated software packages, and connected by a powerful high-speed fiber-optic network". The center possesses multiple high performance clusters including a 8192-core IBM Blue Gene/L cluster, 256-core IBM Power5 based Linux cluster, three 32-core IBM Power4+ processor Regatta systems, a 32-core Intel Itanium2 SGI Altix 3700 system, two 16-core Intel Itanium2 SGI Altix 350 system, a 16-core IBM RS/6000 SP3, and a six 4-core COMPAQ Alpha Server ES40 with a total of 8648 cores and a combined capacity of about 25 Teraflops'. Its IBM Blue Gene/L system is the 3rd powerful system in India according to Top Supercomputers-India and is ranked 213th in the latest Top500 list.

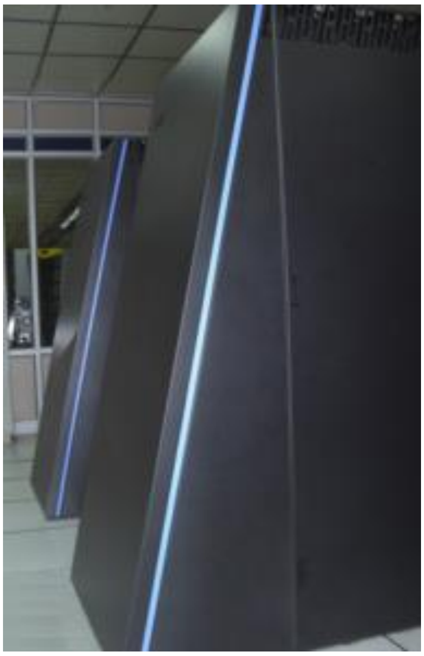


Figure 8 : IBM Blue Gene/L in SERC, IISc, Bengaluru

While we have covered a few major computational facilities in India, the list is by no means comprehensive. We observe that both the number of the HPC facilities and the performance capabilities has been on the increase in the last 5 years. The advent of multicore architectures has enabled quite a few HPC systems in India which have more than 128 cores and a peak performance in excess of 1 Teraflops'. We anticipate that the number of such systems at present to be at least 50 or more. These are predominantly used for various high performance applications. Not surprisingly, only a few (less than 5) of these systems are used for HPC system research.

2.4.2.4 Garuda – Indian Grid Initiative

The National Grid Computing Initiative "GARUDA is a collaboration of science researchers and experimenters on a nationwide grid of computational nodes, mass storage and scientific instruments that aims to provide the technological advances required to enable data and compute intensive science for the 21st century. A computational grid is an aggregation of heterogeneous and geographically distributed resources such as computing, storage and special equipment's. The aim of the grid is to dynamically share resources to facilitate optimal utilization. Building a commanding position in Grid computing is crucial for India. Allowing anyone, anywhere, anytime to access supercomputer level processing power and knowledge resources, grids will underpin progress in Indian science, engineering and business".

The Department of Information Technology (DIT), Government of India has funded the Center for Development of Advanced Computing (C-DAC) to deploy the nation-wide computational grid GARUDA. To achieve its objective, GARUDA brings together a critical mass of well-established researchers, from 45 research laboratories and academic institutions of India, who have constructed an ambitious program of activities. In Proof of Concept (PoC) phase of GARUDA, 45 R and D and academic institutes from "17 cities across the country were connected with an aim to bring "Grid" networked computing to research labs and industry. From April 2008 the Foundation Phase of GARUDA is in progress with an aim to include more users' applications, providing Service Oriented architecture, improving network stability and upgrading grid resources".

Figure 9 : GARUDA – The Indian National Grid Computing Centers

Currently GARUDA has aggregated HPC resources from CDAC centers and Partner institutes totally to over 1500 CPUs and 60TB of storage. "GARUDA has also laid the foundation for the next generation grids by addressing long term research issues in the strategic areas of knowledge and data management, programming models, architectures, grid management and monitoring, problem solving environments, tools and grid services".

To ensure progressive evolution and durable integration, GARUDA is managed by C-DAC with the Grid monitoring and Management Center at Bengaluru. "The GARUDA network is a Layer 2/3 MPLS Virtual Private Network (VPN) connecting select institutions at 10/100 Mbps with stringent quality and Service Level Agreements. This Grid is a pre-cursor to the next generation nationwide Gigabit Network with high performance computing resources and scientific instruments for seamless collaborative research and experiments".

The key deliverable of this project include grid tools and services to provide "an integrated infrastructure to applications and higher-level layers, a pan-Indian communication fabric to provide seamless and high-speed access to resources, aggregation of resources including compute clusters, storage and scientific instruments, creation of a consortium to collaborate on grid computing and contribute towards the aggregation of resources and grid enablement and deployment of select applications of national importance requiring aggregation of distributed resources".

2.4.2.5 HPC Applications

India's HPC procurements are predominantly geared towards supporting the high performance application needs of the country. The different HPC centers of India specialize in various cutting-edge scientific applications. Many applications are developed in-house by application groups to enhance the scientific potential in their respective domains. Some applications are built from mostly off-the-shelf open-source components for various scientific domains to help the domain scientists perform studies related to the Indian context. In this section, we describe the activities related to three primary areas, namely, climate modeling and weather forecasting, bioinformatics, and computational chemistry.

2.4.2.6 Climate Modeling and Weather Forecasting

Climate research in India is focused towards understanding and forecasting the Indian summer monsoons. A widely accepted view is that simulation and forecast of the Indian summer monsoon is one biggest challenges facing atmospheric/climate modellers worldwide. This research is being conducted by Indian researchers using state-of-the-art models for the climate system. They also use global and regional atmospheric models for forecasting and research. Oceanographers in India have used ocean models and climate system models to study the circulation processes in the Indian Ocean. Indian researchers were one of the earliest in the world to use parallel processing techniques for climate modelling and have always been innovative in the use of upcoming technologies to study monsoon and climate.

Forecasting of Weather/climate is done by India Meteorological Department (IMD) and National Center for Medium Range Weather Forecasting, Noida (NCMRWRF). Ocean state forecasting is being conducted at Indian National Center for Ocean Information Systems, Hyderabad (INCOIS). Major Centers for climate research are CDAC, CSIR Center for Mathematical Modelling and Computer Simulation (CMMACS), Indian Institute of Tropical Meteorology, Pune (IITM), Indian Institute of Technology, Delhi (IIT-D), and Indian Institute of Science, Bengaluru, National Aerospace Laboratories, Bengaluru (NAL) and Space Application Center, Ahmadabad (SAC).

CDAC has successfully implemented many atmospheric and oceanographic applications on its Param series of supercomputers. The models implemented include WF, the NCMRWF model and the Community Climate System Model (CCSM). Work is also underway to develop a regional climate model using Regional Ocean Modelling System (ROMS) and Regional Climate Model (RCM). An end-to-end forecasting product (based primarily on WF) called `Anuman', has been developed at CDAC-Pune. Ocean model of Institute of Numerical Mathematics of Russia has been successfully implemented on their computing platforms.

Studies on parallel implementation and scalability have also been conducted here. Application of grid to climate studies is also being performed on the Garuda Grid. CDAC was a major player in the country's first atmospheric modelling inter comparison project called SPIM (Seasonal Prediction of Indian Monsoon). This involved successful implementation and seasonal scale ensemble simulations of five AGCMs belonging to various organizations. This exercise was carried out by CDAC on its Param-Padma supercomputer. Community Climate System Model (CCSM) of NCAR, Climate Forecast System (CFS) and Seasonal Forecast Model (SFM) and UKMO atmosphere/ocean model are some of the prominent applications available on PARAM Padma computing systems.

INCOIS is involved in the mathematical modeling of the climate system (individually / coupled) to obtain better understanding over the less observed regions, since the present network of observations in the ocean is not sufficient to understand the ocean dynamics and thermodynamics completely. Some of the objectives of the INCOIS's HPC system include ocean modeling for providing description of past, present and future state of ocean at appropriate spatial and temporal resolutions, assimilation of in-situ and remotely sensed data (Argo Profiling Floats, Moored Buoys, Ship Observations, Satellite Measurements, etc.,) with the help of suitable ocean general circulation models, providing boundary forcing for atmospheric models by performing forecast runs of ocean models, understanding variability of Ocean and Marine environment, simulation experiment to optimize the observation system and serving as a National Computational Facility for ocean models. INCOIS uses various high performance ocean models including MOM, ROMS, CUPOM and HYCOM, WAM, WAVEWATCH-III and Tsunami N2 model.

NCMRWF is entrusted with the task of generating medium range forecasts (3-15 days). Global weather models at a resolution of about 50 km are being used here. Regional weather models with even higher resolutions are also being used for shorter range forecasts up to 3 days. IMD Delhi generates short-range forecasts up to 3 days while IMD Pune generates seasonal forecasts up to 90 days using numerical models.

SAC The emphasis at SAC is on the use of satellite data for weather/climate studies. Both regional and global models are used for study on the impact of ingesting satellite products on weather forecasting and climate studies. Seasonal forecasts are also generated here in collaboration with NCMRWF.

IITM conducts research on tropical meteorology (and oceanography) with emphasis on Indian summer monsoons. Studies are also being conducted on the likely impact of anthropogenic climate change on the Indian summer monsoon. Regional weather models, global atmospheric models (AGCMs) and coupled ocean atmosphere models are being used at this Center.

CMMACS research is conducted here both in meteorology and oceanography. Meteorological studies include research on seasonal forecasting of monsoons and likely impact of anthropogenic aerosols on the strength of the monsoons. Oceanographically studies involve studies related to circulation in the Indian Ocean, bio-geo-chemical processes in the ocean and data assimilation.

At the Indian Institute of Science (IISc), researchers in the Center for Atmospheric and Oceanic Sciences researchers work on ocean, atmospheric and coupled systems. The emphasis is on understanding mechanisms that govern various processes that affect the Indian summer monsoon. AGCMs, OGCMs and coupled climate system models and regional weather models are used for these studies. Issues such as the impact of anthropogenic (black carbon) aerosols on the Indian summer monsoon, impact of atmosphere on oceanic parameters over the Indian region, study of the Indian Ocean Dipole, impact of African and Himalayan topography on monsoons etc., have been carried out using these models.

India's first parallel implementation of a climate model was conducted by IISc in collaboration with NAL and the first major climate system (coupled model) simulation conducted in association with CDAC. Studies have successfully conducted to increase scalability of atmospheric models using message-compression techniques. A new load balancing algorithm has been developed and successfully implemented in a climate system models (one of the few such exercises conducted worldwide on a coupled climate system model). Currently work is underway to grid-enable a climate system model. This involves not only modifying the climate system model but also development of related middleware to facilitate concurrent execution of subsystems at multiple sites.

NAL has been developing its own parallel computing system, for over two decades. Both hardware and related software are developed here. The hardware and software design has been done keeping meteorological applications such as the spectral global prediction models in mind. The novelty of the communication switch developed here is that global operations (such as global sums, max, min etc.,) are conducted on the switch itself and the resultant information is sent to the computing elements. This significantly reduces bandwidth demands. Atmospheric models have been re-engineered and re-coded here. Starting with NCEP global weather forecast model, a new model called VARSHA, has been developed. The latest version under development uses object-oriented programming concepts. Research mode forecasts are being generated on medium range and seasonal scales using these models.

IIT-Delhi AGCMs and regional weather models are used at this Center for study of monsoons and intense weather systems over the Indian region. A global spectral model has been successfully implemented based on longitudinal decomposition instead of the conventional latitudinal decomposition. Scalability studies for such decomposition have also been conducted. Using these models issues such as impact of Eurasian snow cover on the Indian monsoon have been addressed. Ocean models are also being used to study coastal and large-scale circulation of the Indian Ocean.

2.4.2.7 Computational Chemistry/Physics

Research problems pursued in the computational chemistry/physics area can be broadly classified into two; (i) Study of electronic structure, and (ii) Dynamics of complex systems. In the former, traditionally the focus has been on crystalline solids and of late on nanostructure materials, primarily by practitioners of computational physics using approaches such as tight binding theory, muffin tin orbital's, many body calculations and so forth. Another independent stream of workers interested in electronic structure are quantum chemists, whose primary interest used to be small molecules studied using semi-empirical, Hartree-Fock (HF) or post HF methods. The advent of density functional theory (DFT) with extremely robust exchange-correlation functional has energized these two distinct communities and has led them to investigate non-traditional atomic and molecular architectures in the areas of nanomaterials, supramolecular systems and so forth.

The second direction of research in computational chemistry/physics is the study of complex systems. Until a decade ago, many research groups used to study the structure and dynamics of simple liquids, atomic as well as molecular ones, using primarily the technique of molecular dynamics (MD) or alternately using Monte Carlo (MC). These methods employ an empirical inter atomic potential of interaction and the time evolution of the system was studied. In the recent past, this category of researchers has been increasingly focusing on phase behavior, mesoscale structure (morphology) and slow dynamics in complex systems. This development has been made possible due to many factors such as (i) faster algorithms (such as FFTs for calculating Coulomb interactions), (ii) better single processor performance, (iii) easier availability of MPI based public domain codes, and (iv) commoditization of HPC hardware and support software (such as compilers, libraries etc.).

2.4.2.8 Using Clusters

State-of-the-art multi referenced Coupled-Cluster calculation of accurate electronic structure of atomic systems are important for spectroscopic studies, lifetimes of energy levels, transition probabilities, polarizabilities and to probe particle and nuclear physics by combining with experimental measurements. Coupled cluster at Singles and Doubles (CCSD) level for both relativistic and non-relativistic methods have been ported and executed on PARAM Yuva cluster.

Extensive ab initio calculations on nonmaterial using density functional pseudo potential plane wave method on a variety of Al-Au clusters have shown exceptional stability of 58 valence electron (leaving the 5d electrons of Au) clusters such as an empty cage doubly charged icosahedral fullerene Al12Au20 and an endohedral Al12Au2 fullerene anion in which a gold atom lies at an off-center position inside the Al12Au20 cage. Formation of such caged structures by metal atoms is very unusual and novel. Further detailed studies on different endohedral doping as well as other caged and small clusters of Al-Au and Al-transition metals have been carried out. Stabilities of Al-Au clusters having 18, 20, and 40 valence electrons corresponding to magic behavior in a helium model have been explored. Studies on many other systems in bulk and Nano forms are also being conducted.

CMSD, Hyderabad, conducts research in various aspects of electronic structures including physics of low dimensional systems, topological defects in restricted geometries, critical phenomena, quantum chemistry, molecular modeling and design of new materials.

The cluster at CCMS, JNCASR, is exclusively devoted to carrying out computations related to materials science. Typical application software includes CPMD, LAMMPS, Quantum Espresso, SIESTA, VASP, and ADF and many home brew codes. Broadly they fall into two categories: those based on quantum mechanical approaches and those which are not an example of the latter being LAMMPS. All codes have been found to scale rather well, provided the problem size is large enough. CPMD, SIESTA, and Espresso are based on density functional theory and are used to study the details of electronic and atomic structure and dynamics of various advanced materials, including metal DNA complexes, multiferroics, surfaces, Nano-catalysts, ionic liquids etc. LAMMPS is used to model supercritical carbon dioxide, room temperature ionic liquids and various glass forming liquids using empirical potential molecular dynamics.

VASP is used to study many magnetic and other materials possessing interesting electronic structure, while ADF which is based on quantum chemical approaches is used to study molecular complexes. CPMD and LAMMPS have exhibited linear scaling for large problems.

At the Indian Institute of Technology, Kanpur, the HPC facilities are extensively used to carry out computational studies on chemical dynamics in condensed phases, surface adsorption and related kinetic processes, chemical reaction dynamics in gas phase, structure and energetic of biologically relevant molecules and many other key problems in chemical sciences and related areas. While Gaussian03 has been used for high level quantum chemical calculations of molecules and clusters at zero temperature, CPMD, VASP and Quantum Espresso are used for finite temperature simulations clusters and condensed phases using full many-body quantum potentials. These later packages are also used for many of the static pseudo potential based quantum calculations of chemically interesting systems which appeared to be too large for explicit all-electron calculations. For very large systems, such as interfaces, solutions of complex solutes etc.

AMBER, DLPOLY or GROMOS are used for empirical potential based dynamical simulations. An interface of GROMOS-CPMD is also used combined classical-quantum simulations of many of the chemical systems of interest such as proton transfer through narrow hydrophobic pores. Up to 24 processors for a single job for quantum were used and combined classical-quantum simulations and the scalability has been found to be very good in this domain.

2.4.3 High Performance Computing Facility- University of Hyderabad

The study of "the passage from the micro world of atoms and molecules to the macro world of solids, liquid and gases calls for an understanding of a variety of phenomena in physics, chemistry, biology and engineering science and technology and related areas. Atomic lasers, molecular computers, drug receptor interactions, industrial catalysts, lubricants, and industrially important materials form part of this continuum and an understanding of this evolution needs all the three components of research, viz. theory, experiment and computation".

"Computer based simulations now form an integral part of modern research methodology and in this era of science-driven-engineering and directed basic research, the role of scientific research, based on modeling, simulation and design, is of paramount importance. The primary requisite in using the third avenue of research for solving complex problems is a working, state-of-the-art High Performance Computing (HPC) Center".

The University of Hyderabad, "having expertise in many of the above areas, fully appreciates the inter-dependence of Science, Engineering and Technology, and launched this uniquely conceived new programme. This initiative was launched through an imaginative programme of the UGC (recognizing the University for its Potential for Excellence) by establishing a designated Center for such activity, Center for Modelling Simulation and Design (CMSD)".

This "programme has been receiving generous support from DST under its FIST program. CMSD aims to nurture cross-disciplinary bridges, which are effective in generating new knowledge and creative explorations. The human resources generated from such efforts will be invaluable. Training individuals and organizations in specific hardware and software, undertaking of consultancy and turnkey projects, help convert real life phenomena into appropriate mathematical and computational models etc., are some of the important tasks that CMSD has embarked on".

This Center became operational from its new premises in December 2004. "One of the unique academic features of this Center is that all the active computational scientists working in widely different academic disciplines in the university campus are associate faculty of the CMSD, and contribute their expertise and experience in furthering its objectives. Some of the research interests of these members include: physics of low dimensional systems, topological defects in fluids in restricted geometries, critical phenomena in complex fluids and magnetic systems, Monte Carlo simulations and development of novel sampling techniques, genomics and bioinformatics, protein folding, cognitive neuroscience, computational intelligence, natural language understanding, Very Large Scale Integration (VLSI), quantum chemistry and Density Functional Theory(DFT), molecular modeling, drug design and delivery, design of new materials etc."

2.5 Conceptual Framework

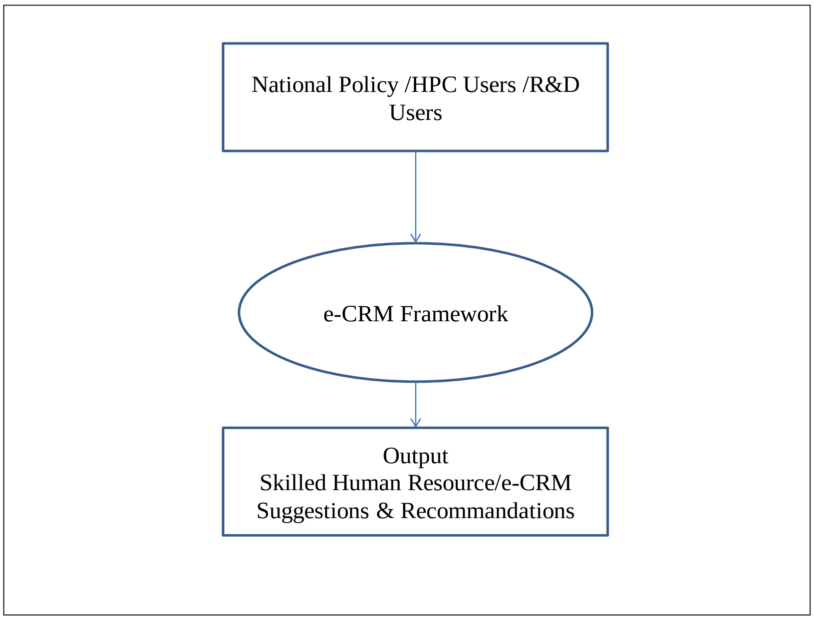


Figure 10 : e-CRM for UOH Framework

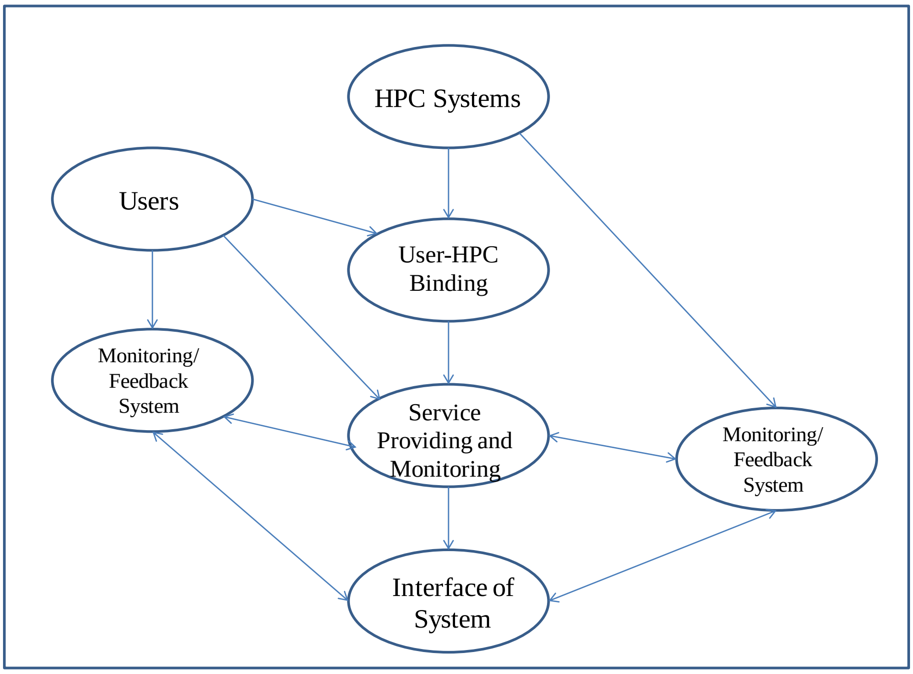


Figure 11 : e-CRM-HPC UOH Framework

The Influencing parameters on user satisfaction of High Performance Computing are User interface, Performance evaluation, adoptive strategies for enhance Services.

As this is a first of its kind to the best of our knowledge the concept of e-CRM framework interface module is the subject matter of study.

As first step data pertaining to users and HPC infrastructure and polices has been complied and user satisfaction level has been gathered through scientifically designed questionnaire and Interview. The data has been analyses for building the advisory system.

2.6 Summary

This chapter has presented a detailed about the Customer Relation Management, its relationship management, concepts and role. The electronic Customer Relation Management, key features, components of e-CRM, differences between CRM and e-CRM and High Performance Computing Facility, evolution of HPC, centers in INDIA with details of hardware and software products, usage of HPC.

3 Literature Review

3.1 Higher Education

Sukanta Sarkar (2012) author attempts to highlight the role of ICT in higher education for the 21st century. That ICTs have impacted on educational practice in education to date in quite small ways but that the impact will grow considerably in years to come and that ICT will become a strong agent for change among many educational practices. It is evident from the study that use of ICT in education is increasing very rapidly in various states of India. One of the most common problems of using Information and Communication Technologies (ICTs) in education is to base choices on technological possibilities rather than educational needs. In developing countries where higher education is fraught with serious challenges at multiple levels, there is increasing pressure to ensure that technological possibilities are viewed in the context of educational needs.

The use of ICT in education lends itself to more student Center learning settings and often this creates some tensions for some teachers and students. But with the world moving rapidly into digital media and information, the role of ICT in education is becoming more and more important and this importance will continue to grow and develop in the 21st century. Thus, the paper suggests that ICT in higher education is not a technique for educational development but also a way of socio-economic development of the nation.

Neeru Snehi (2009) Higher education in the country is experiencing a major transformation in terms of access, equity and quality. This transition is highly influenced by the swift developments in information and communication technologies (ICTs) all over the world. The optimal utilization of opportunities arising due to diffusion of ICTs in higher education system presents a profound challenge for higher education institutions.

At the same time the introduction of ICTs in the higher education has profound implications for the whole education process ranging from investment to use of technologies in dealing with key issues of access, equity, management, efficiency, pedagogy and quality. In this regard the paper addresses the opportunities and challenges posed by integration of ICTs in various aspects of higher education in the present scenario. The paper argues for addressing the issues through formulation of policies and strategies to accrue following potential future developments in ICTs and to integrate them in education sector to transform higher education.

Dr. R.Krishnaveni (2010) the higher education system is required for overall prosperity of a nation. A tremendous growth in the higher education sector had made the administration of higher education institutions complex. Many researches reveal that the integration of ICT helps to reduce the complexity and enhance the overall administration of higher education. This research study has been undertaken to identify the various functional areas to which ICT is deployed for information administration in higher education institutions and to find the current extent of usage of ICT in all these functional areas pertaining to Information administration. The various factors that contribute to these functional areas were identified. A theoretical model was derived and validated.

Deepti Gupta (2012) the author is discussed about, India's education system is often cited as one of the main contributors to the economic rise of India. The size of India's higher education market is about $40 billion per year. Presently about 12.4 percent of students go for higher education from the country. If India were to increase that figure of 12.4% to 30%, then it would need another 800 to one thousand universities and over 40,000 colleges in the next 10 years. This paper presents the development and present scenario of higher education in India by analyzing the various data and also identifies the key challenges that India's higher education sector is facing.

Uttam Kr Pegu (2014) the focus of this paper is to examine the role of Information and Communication Technology (ICT) in higher education in India. The emergence of ICT has fundamentally changed the practices of not only business and governance but education as well. While the world is moving rapidly towards digital media, the role of ICT in education has become increasingly important. There has been an unprecedented growth in the use of ICTs in teaching, research and extension activities. The sudden boom in Information Technology has transformed the way how knowledge is disseminated today.

One of the changes it has brought about is the way how teachers interact and communicate with the students and vice-versa. Given the fact that higher education in India is plagued by the challenges of inadequate technology access and inequity coupled with economic considerations and technological know-how, it remains to be seen how Information and Communication Technology can actually burgeon the students and how it can foster change in this aspect. Finally, this paper assesses how Information Technology has facilitated the growth in interactive learning and what has been its impact in the higher educational scenario in the country.

Ashish Hattangdi et al (2008) discussed**, "**Changes in the economic and social fundamentals call for transformation in the skills, capabilities and attitudes of the masses. This requires a shift in the delivery and pedagogy used in the current education system. The purpose of this paper is to promote integration of Information and Communication technologies (ICT) in higher education for imparting easily accessible, affordable and quality higher education leading to the economic growth of India".

The focus of the paper is on the benefits that ICT integration in education can provide, right from breaking time and distance barriers to facilitating collaboration and knowledge sharing among geographically distributed students. The findings reveal that it also facilitates sharing of best practices and knowledge across the world.

ICT increases the flexibility of delivery of education so that learners can access knowledge anytime and from anywhere. It can influence the way students are taught and how they learn as now the processes are learner driven and not by teachers. This in turn would better prepare the learners for lifelong learning as well as to contribute to the industry. It can improve the quality of learning and thus contribute to the economy. It provides several tangible and intangible benefits for all stakeholders involved in the economic growth of the country.

Wider availability of best practices and best course material in education, which can be shared by means of ICT, can foster better teaching. ICT also allows the academic institutions to reach disadvantaged groups and new international educational markets. Thus, ICT enabled education will ultimately lead to the democratization of education. Especially in developing countries like India, effective use of ICT for the purpose of education has the potential to bridge the digital divide.

The paper also "explores the factors related to policy, planning, technical requirements as well as the training required for the stakeholders for the successful implementation of ICT in an education system. These steps would ensure that accountability, quality assurance, accreditation and consumer protection in ICT based education is taken care of".

Arti Bajpai et al (2010) states that Information and Communication Technology (ICT) are increasingly becoming crucial part of the education system. ICT has changed the style of functioning of the educational system and its governance.

The author is discussing about the development of ICT applications has brought about markedly drastic technological, social and economic transformations. These changes have caused educational institutions, administrators, teachers to rethink their roles, teaching and vision for future.

The sustainability of a nation in the era of knowledge economy depends on the effective educational system. Productivity is an economics concept where productivity is considered as the comparative analysis of input and outputs. In educational system the inputs are teachers, students, classroom material, equipment of teaching, methods of teaching and outputs are quantity and quality of student learning. The proper integration of ICT with teaching/learning environment increases education and increased productivity. ICT provides various opportunities to educational learners and make teachers aware of their new roles and responsibilities in teaching and learning process. The growing use of ICT will change many of the strategies employed by both Teachers and Students in the learning process.

The role of ICT the educational administration is recurring and unavoidable. ICT has enabled us to monitor and evaluate what is learned, how it is learned and when and where learning took place. It is also enable the educational management system to discharge various functions such as, conduction of exams, coordination between potential institutes, alumni network. ICT also work for nontraditional students by providing internet based education to them anytime and anywhere and these internet technologies enables innovative ways of teaching e.g. Tata Sky educational system. ICT is going to play a vital role in bringing about qualitative change in every aspect of our life in general and that of governance of education.

3.2 Customer Relationship Management

Sigala (2004) author is discussing about the implementation of CRM applications. Although CRM is one of the fastest growing management approaches being adopted across many organizations and particularly tourism and hospitality firms, the deployment of CRM applications has not always delivered the expected results while many CRM initiatives have failed. Consequently, the inability of CRM applications to deliver expected benefits has not only intensified the validity of previous findings and claims regarding the ICT productivity paradox, but it has also boosted current research. However, although the latter provides anecdotal evidence of the impact of ICT management practices on CRM effectiveness, there is a lack of empirical studies examining the relationship between CRM management and performance aspects.

This study aims to fill in this gap by investigating the relation between firms' CRM applications and exploitation with their ICT management practices and CRM benefits. The investigation and validation of the former are valuable, since it would enable managers to maximize CRM benefits by identifying and allocating the appropriate resources, time and efforts to CRM implementation. Relations are tested by gathering data from Greek tourism and hospitality companies. Findings provide useful practical suggestions for CRM evaluation and implementation strategies, while implications for future research are analyzed.

Kristel Paulissen et al (2007) author is identifying the gaps in literature for the period of 2000 to 2005. The status of the CRM literature is investigated for the period of 2000 to 2005, in order to provide an overview of academic research on the subject and to identify gaps in the current literature. To provide as complete picture of CRM as possible, the Information Systems (IS) as well as the Marketing literature was systematically reviewed. From both disciplines the top journals and a number of international conferences were analyzed.

Selected publications were reviewed in a structured way and categorized according to the different phases in the CRM lifecycle: adoption, acquisition, implementation, use and maintenance, evolution and retirement. It appears that less attention has been devoted to implementation issues and to the evolution and retirement phases. Furthermore, a difference in attention was found between the IS and Marketing literature: while researchers of the latter focused mainly on the adoption and use phases, IS researchers' attention was more evenly distributed over the lifecycle.

Abeer I et al (2011) author is discussing the ERP implementation in universities environment. An ERP system plays an important role in managing business processes. Recently, many universities have implemented ERP systems. However, little research has been conducted regarding these systems in the higher education sector. This paper "explores and analyzes the existing literature on ERP implementation and attempts to identify the critical success factors for a successful implementation of an ERP in higher education's institutions in Saudi Arabia. We use Madar, which is an ERP system developed in King Saud University in Riyadh, Saudi Arabia, as a case study to measure the success in ERP implementation from technical and user perspectives. This paper proves that the most important critical success factors of ERP implementation in Higher Education sector in Saudi Arabia was project management. This study has contributed to academic research by producing the empirical evidence to support the theories of CSFs and ERP implementation success".

Dejan STOJKOVIC et al (2012) Electronic business (e-business, defined as business activities conducted over the Internet) has been one of the most remarkable information technology innovations in the last few decades (e-business era). With the involvement of the Internet in the Customer Relationship Management (CRM) concept, its functions have been changed a lot. The Internet enables ready identification of the customer/visitor, cost-efficient data collection, personalization, adaptation, and interactivity in the CRM process. Here comes electronic CRM (e-CRM). The purpose of this paper was to review that how customer relationships should be managed (CRM) in the age of the e-business.

Darrell K Rigby et al (2002) in this paper author is discussing about the CRM practices. "CRM allows companies to gather customer data swiftly, identify the most valuable customers over time, and increase customer loyalty by providing customized products and services. CRM aligns business processes with customer strategies to build customer loyalty and increase profits over time". More specifically, our research shows that many executives stumble into one or more of four pitfalls while trying to implement CRM.

1. Implementing CRM before creating a customer strategy.
2. Rolling out CRM before changing your changing your organization to match.
3. Stalking, not wooing, customers.

S. Sathish et al (2002) the technology and the climate to support the tenets of CRM, which are new, have become available recently. However, researchers face the problem of defining CRM and mapping out what it entails. CRM is defined as a business strategy that seamlessly integrates every aspect of business that touches the customer. Based on this definition, this paper suggests that CRM study should be approached as a study of five sub-topics: marketing and sales, project implementation and management, e-business, knowledge management and supply chain management. Each of which is established in its own right.

Liu et al (2008) Customer Satisfaction Index (CSI) is an important concept for evaluating the quality of service in e-commerce. It permits to evaluate the validity of an e-commerce operation from the point of view of customers. In this paper, the authors presented a model of CSI in e-commerce using fuzzy techniques and provide a method for calculating CSI, expressed in a five levels quantity table.

Rabaai et al (2009) This paper is part of a larger research effort that aims to contribute to understanding the phenomenon of ERP implementations and evaluations in Higher Education

Institutions (HEIs) in the Australasian region; "it identifies, Previously reported, Critical Success Factors (CSFs) in relation to ERP system Implementations and discusses the importance of these factors".

In the worldwide, adoption of ERP Systems in Higher Education Institutions (HEIs) has increased substantially over the past decade. Though the difficulties and high failure rate in implementing ERP systems at university environments have been cited in the literature, research on Critical Success Factors (CSFs) for ERP implementations in this context is rare and fragmented.

Abugabah et al (2010) this paper aims at providing a critical review of previous research in ERP system in higher education with a special focus on higher education in Australia. The research not only forms the basis of an evaluation of previous research and research needs, it also makes inroads in identifying the payoff of ERPs in the sector from different perspectives with particular reference to the user. The paper is divided into two parts, the "first part focuses on ERP literature in higher education at large, while the second focuses on ERP literature in higher education in Australia. ERP systems are the largest software applications adopted by universities, along with quite significant investments in their implementation". However, unlike other applications little research has been conducted regarding these systems in a university environment.

Zornada (2005) The article presents research results in the field of ERP systems and their use in higher education institutions (universities, faculties and independent higher education institutions) in Slovenia and abroad. On the basis of the study of the supply on the market and by a thorough study of cases from practice we try to find similarities and differences between Slovenian higher education institutions and world trends. With the computerization of business activities in higher education institutions ERP vendors quickly perceived a new market opportunity. Enhancements or mere adaptations of these solutions, which stemmed from the experience in business practice, were not always successful. By taking a global view, the present needs and future expectations of higher education institutions on one side and ERP vendors on the other side in domestic higher education environment were analyzed.

3.3 Electronic Customer Relationship Management (e-CRM)

Kelley O'Reilly et al (2009) a paucity of research on the motivations and goals of vendors who develop electronic customer relationship management (e-CRM) tools and systems exists in the literature. This is an important gap in the literature because many e-CRM systems are products of outsourcing (to vendors). This paper aims to discuss these issues.

Design/methodology/approach: This exploratory case study focuses on an international van-based service franchise and the experiences of the vendor, company, and franchisees as they design, develop, and implement certain e-CRM tools. Participants include the president and founder of the e-CRM vendor company, the chief executive officer, chief financial officer, and marketing director from the franchisor company, and six franchisees. This paper is triangulated via personal interviews, member-checking interviews, and relevant literature from information systems (IS) and marketing.

Findings: Specifically, this paper sheds light on the role and influence of the vendor in the design, development, and delivery of e-CRM tools. Managerial implications include: Customer Relationship Management (CRM) requires a balance of online and offline activities; vendors may distort the balance between online and offline marketing efforts; and strategic policy should center on the priorities of the franchisor, franchisees, and end customers.

Originality/value: This paper fulfills an identified knowledge gap by capturing the "voice" of the vendor who has historically been overlooked in the literature. The research insights are particularly salient for company managers and marketing practitioners alike. Study limitations and suggestions for future research are also discussed.

Balaji Padmanabhan et al (2003) previous work on the solution to analytical electronic Customer Relationship Management (e-CRM) problems has used either Data-Mining (DM) or optimization methods, but has not combined the two approaches. "By leveraging the strengths of both approaches, the e-CRM problems of customer analysis, customer interactions, and the optimization of performance metrics (such as the lifetime value of a customer on the Web) can be better analyzed". In particular, many e-CRM problems have been traditionally addressed using DM methods. There are opportunities for optimization to improve these methods.

Farida Bhanu et al (2010) the rapid development in the Internet technology has accelerated the support of Customer Relationship Management (CRM) systems to customers. Hence, electronic CRM (e-CRM) systems emerged. "The proposition of this paper is that the success of introduction of e-CRM performance can be improved by interweaving knowledge management concept. The aim of this study is to fit in the selected KM and e-CRM models within four resource dimensions based on Resource-based View Theory (RBV): technology, knowledge, customer and business. The study identified that CRM Development Stages Model and Balance Scorecard Perspective of e-CRM Model provide better fit to the four resource dimensions that can be focused in developing a KM-based e-CRM model".

Balaji Padmanabhan et al (2006) Due to the vast amount of user data tracked online, the use of data-based analytical methods is becoming increasingly common for e-business. "Recently the term analytical e-CRM has been used to refer to the use of methods in the online world. A characteristic of most of the current approaches in e-CRM is that they use data collected about users' activities at a single site only and. as we argue in this paper, this can present an incomplete picture of user activity".

However, "it is possible to obtain a complete picture of user activity from across site data on users. Such data is expensive, but can be obtained by firms directly from their users or from market data vendors. A critical question is whether such data is worth obtaining, an issue that little prior research has addressed". In this paper, "using a data mining approach, we present an empirical analysis of the modeling benefits that can be obtained by having complete information. Our results suggest that the magnitudes of gains that can be obtained from complete data range from a few percentage points to 50 percent, depending on the problem for which it is used and the performance metrics considered. Qualitatively we find that variables related to customer loyalty and browsing intensity are particularly important and these variables are difficult to derive from data collected at a single site". More importantly, we find that it has to collect a reasonably large amount of complete data before any benefits can be reaped and caution against acquiring too little data.

Mohamed Khalifa et al (2005) in this paper, we develop, operationalize and empirically test "a temporal model explaining the relationship between three categories of e-CRM (i.e., pre-purchase, at-purchase and post-purchase e-CRM) and online customer satisfaction at two phases of the customer lifecycle, i.e., attraction and retention. The results of a longitudinal survey of the online customers of hardware retailers provided strong support for the model and revealed the dominant role of pre-purchase e-CRM in satisfaction formation at the attraction phase and the prevalence of post-purchase e-CRM at the retention phase". Specific e-CRM features are identified as satisfaction drivers, providing insights for important paradigm shifts.

Howard G. Bernett et al (2002) today's online consumer has more complex needs and much higher expectations than ever before. Customers not only want to shop and get customer service through multiple communication channels, such as the telephone, Web text chat, electronic mail, and the Web, they desire the ability to move seamlessly from one medium to another. To support this capability, Customer Relationship Management (CRM) is evolving into electronic CRM "e-CRM." This paper presents the evolution of e-CRM, describes several current trends, and looks at the future of e-CRM.

Talhat Alhaiou (2009) the purpose of this paper is to propose a model for the relationship between e-CRM and E-loyalty by conceptualizing that e-loyalty is influenced by e-satisfaction, e-trust, and multi- dimensional aspects of e-CRM. "In order to capture the full picture for this relationship, we attempt to cover the complete purchase experience by focusing on transaction cycle (Pre-Purchase, At-Purchase, and Post-Purchase).different Components of e-CRM have differing effects on e-loyalty". This study strengthens the literature by adding different components of e-CRM as a possible critical antecedent in the model of e-loyalty development and attempts to build a stronger holistic model by including e-CRM features.

M. Khalifa et al (2009) In this study, we address these gaps by following a functional approach and taking a temporal view in developing and testing a model explaining the effects of various types of electronic customer relationship management (e-CRM) functions on customer satisfaction in the context of online shopping. "A framework based on the transaction cycle is used to classify. e-CRM functions into pre-, at-, and post-purchase e-CRM. Two distinct temporal phases, i.e. attraction and retention, are identified. The results of a longitudinal survey involving 670 customers of hardware retailers demonstrate the appropriateness of the functional approach in investigating e-CRM success and the necessity of the temporal conceptualization of customer satisfaction. The theoretical and practical implications of these results are discussed".

Jagdish N. Sheth et al (2001) Customer relationship management (CRM) has once again gained prominence amongst academics and practitioners. However, there is a tremendous amount of confusion regarding its domain and meaning". In this paper, "the authors explore the conceptual foundations of CRM by examining the literature on relationship marketing and other disciplines that contribute to the knowledge of CRM. A CRM process framework is proposed that builds on other relationship development process models. CRM implementation challenges as well as CRM's potential to become a distinct discipline of marketing are also discussed in this paper.

Shirin Alavi et al (2011) this study has been conducted to do an analysis of the online community of Apple in detail by using Netnography, which is a new qualitative, interpretive research methodology that uses Internet optimized ethnographic research techniques to study an online community. As a marketing research technique, 'Netnography' uses the information publicly available in online forums to identify and understand the needs and decision influences of relevant online consumer groups.

The identification of parameters that aids participant trustworthiness can aid long term strategic decision making. It is deduced that increased consumer participation in a community results in increased reciprocity, and more accurate peer-to-peer responses translate into greater peer acceptance, which is indicative of greater trustworthiness of a participant. This implies that trustworthiness and popularity of a forum member is a direct function of his ability to give correct answers (level of Consumer Product knowledge) to participants and their level of participation. Peer-to-peer consumer interaction is useful, and relevant incentives to consumer evangelists will be in the long-term organizational interest. Concepts of business online communities coupled with commerce, content and communication are widely discussed as the essential components of a successful organizational web presence.

In a marketing context, the significance of a community can be viewed as an extension of the relationship marketing paradigm. The interest in the online communities from a marketing perspective is driven by the belief that the complex network of personal relationships and increasing identification with the group as a community provide a foundation for a very attractive business model. Customers and other stakeholders are only likely to be interested in communities that offer them value.

Parimal H. Vyas et al (2004) Business moves fast and very fast. The relationship with the target customers begins as much after the sale as it before the sale. It would be true to state that a shift of marketing to e-Marketing and its goal from customer service to customer relationship where designing of e-Marketing strategies are directly influenced by advances in IT that has led to growth of marketing phenomenon called as e-CRM. It too focuses on attracting, acquiring and retaining customers at a click of the mouse.

e-CRM necessitates integration of companies' internal processes in form of data organizing and availability as well as external processes in way of viz., giving customers what they want; providing timely information, access to third party information and easy-to-use ordering processes. Making company's website customer-centric is crucial for a successful implementation of e-CRM strategy while designing customized websites keeping in mind that customers should feel welcomed, informed, secure and are presented with cohesive information.

Successful implementation of e-CRM strategy calls for web design considerations with regard to target audience, website navigation, customer personalization and sound, video and other special design considerations and its integration with e-Marketing processes to direct efforts towards establishing, developing.

Changsu Kim et al (2008) the study, from customers perspectives, develops a conceptual framework for e-CRM to explain the psychological process that customers maintain a long-term exchange relationship with specific online retailer. “The conceptual framework proposes a series of causal linkages among the key variables affecting customer commitment to specific online retailer, such as perceived value (as cognitive belief), satisfaction (as affective experience) and trust (as co-native relationship intention)”.

Three key exogenous variables affecting Internet online shopping experiences, such as perceived service quality, perceived product quality, and perceived price fairness, are integrated into the framework. This study empirically tested and supported a large part of the proposed framework and the causal linkages within it. The empirical results highlight some managerial implications for successfully developing and implementing a strategy for e-CRM.

Faramak Zandi et al (2011) The rapid growth of the Internet and the expansion of electronic commerce applications in manufacturing have given rise to Electronic Customer Relationship Management (e-CRM) which enhances the overall customer satisfaction. However, when confronted by the range of e-CRM methods, manufacturing companies struggle to identify the one most appropriate to their needs.

This paper presents a novel structured approach to evaluate and select the best agile e-CRM framework in a rapidly changing manufacturing environment. “The e-CRM frameworks are evaluated with respect to their customer and financial oriented features to achieve manufacturing agility. The e-CRM frameworks are prioritized according to their financial oriented characteristics using a fuzzy group Real Options Analysis (ROA) model. Next, the e-CRM frameworks are ranked according to their customer oriented characteristics using a hybrid fuzzy group permutation and a four-phase fuzzy Quality Function Deployment (QFD) model with respect to three main perspectives of agile manufacturing (i.e., strategic, operational and functional agilities). The best agile e-CRM framework is selected using a Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) model".

Shannon Scullin et al (2002) author discussing about the benefits e-CRM the e-CRM is becoming more and more necessary as businesses take to the web. No longer can web-enabled companies rely on the traditional brick and mortar strategies that have gotten them to where they are today. Such organizations have to evolve with the market instead of behind it. "This paper promotes the value of e-CRM, explores its benefits, outlines the focal points to address prior to implementation, outlines potential pitfalls during implementation and ways to avoid, takes a look at recent trends and presents a proven e-CRM success story".

Dr. Alok Kumar Rai (2011) in the world of intense competition, where the customers are more demanding and the competitors are just clicks away, better customer relationship management is the only source of competitive advantage. "Creation of strong relationship is the essence of Customer Relationship Management (CRM), which in turn results in revenue optimization, profitability and customer satisfaction".

However, due to increase in product offerings, increased competition and compressed marketing cycle time; managing customer relationships is becoming more complex. CRM means moving from "Inside-out": the seller-driven enterprise to "Outside-in": the customer driven enterprise. The e-CRM is the combination of business process and technology that seeks to understand a company's customer from a multifaceted perspective. e-CRM involves capturing and integrating all customer data from anywhere in the organization, analyzing and consolidating it into information and then distributing the results to various systems and customer contact points across the enterprise.

Mohamed Khalifa et al (2005) in this paper, we develop, operationalize and empirically test a temporal model explaining the relationship between three categories of e-CRM (i.e., pre-purchase, at-purchase and post-purchase e-CRM) and online customer satisfaction at two phases of the customer lifecycle, i.e., attraction and retention. "The results of a longitudinal survey of the online customers of hardware retailers provided strong support for the model and revealed the dominant role of pre-purchase e-CRM in satisfaction formation at the attraction phase and the prevalence of post-purchase e-CRM at the retention phase. Specific e-CRM features are identified as satisfaction drivers, providing insights for important paradigm shifts".

Osama K. Harfoushi et al (2013) Electronic Customer Relationship Management systems are considered very important for business to compete in this vital environment. However, one of the main problems that faces organizations is how to design and develop a usable applications. This paper suggests a usability model to help organization to employ high usable e-CRM systems.

Olof Wahlberg et al (2009) the "main purpose of this paper is to add to the image of CRM research by identifying trends and topics, using the perspective of CRM when it is divided into the four separate branches, namely those of Strategic CRM, Analytical CRM, Operational CRM and Collaborative CRM. In addition to this, the purpose is to identify under researched areas in the body of CRM research in which there are research questions requiring to be addressed by means of further research".

Findings: "The development of the number of CRM articles published in the journals signals a maturity within the CRM research field. Articles on Strategic and Analytical CRM dominate the research in this field. The focus has changed from Analytical to Strategic CRM, which is the most popular branch by the end of the period reviewed".

Research implications: "Three implications for future research on CRM are noted: 1. there is need for more research within the area of Operational CRM and Collaborative CRM. 2. There is a need for research with a resource based view on CRM. 3. There is a need for more research on CRM in SMEs, using a frame of reference that accounts for SME features".

Originality/value: "The paper presents an image of the development of the CRM research field using an image of CRM that is well established, yet which has not been used in earlier literature reviews. It also points to the development of the CRM research field during the past two decades, including an increased focus on Strategic CRM. Furthermore, it points to voids in CRM research that call for further studies".

Chun-Chu Liu et al (2012) as the Taiwanese government gradually opens up the country's banking sector in recent years, the number of financial institutions of Taiwan has increased rapidly. Until the end of January 2010, the number of the domestic banks is up to 37, the average number of the customers served in each branch is less than 4,000. As all banks wish to be more competitive in such an environment, new advertising and marketing skills are taken.

New banking services and technology are also provided in order to attract more customers. The study aims to discuss the relationship among three aspects including the electronic Customer Relationship Management (e-CRM), Customer Satisfaction, Customer Loyalty, and we choose Bank Sinopec users as subject. In addition, the following results are concluded by statistics and analysis: 1. Using e-CRM had obvious on the customer satisfaction and customer loyalty. 2. Customer satisfaction had obvious on the customer loyalty.

Ng Kim-Soon et al (2012) Small Company has a relatively simple e-CRM to improve their customer relationships and information gathering management to create competitive advantage. The use of e-CRM for small company is in a different context as compared to that for the large company. The technology acceptance model was used to investigate the relationship of perceived usage of e-CRM with business performance of all the identified seventy-one (71) small companies that sell cars at Batu Pahat town. Relationship marketing principles have seldom been applied to the small and medium-sized enterprise (SME). Mean test and multiple regression were used to examine internet CRM and business performance.

Aileen Kennedy (2005) Electronic customer relationship management (e-CRM) is seen to arise from the consolidation of traditional CRM with the e-business applications marketplace and has created a flurry of activity among companies. "e-CRM is the proverbial double-edged sword, presenting both opportunities and challenges for companies considering its adoption and implementation. This paper explores the marketing opportunities e-CRM creates for companies such as enhanced customer interactions and relationships as well as personalization options, all of which are potential sources of competitive advantage. It also explores the challenges confronting companies implementing e-CRM such as managing an on-line channel, data integration issues and information technology (IT) architecture challenges. Directions for future research are also suggested".

Nicholas C. Romano, Jr. et al (2009) in this paper, we address electronic Customer Relationship Management (e-CRM) from the perspective of five IS research areas. "Our purpose is to define a model to examine the relationships among and between these five research areas within e-CRM and to propose how they might be integrated to further research in this area. We begin with a discussion of each of the research areas, followed by a brief review of relevant literature. Next we present a framework that focuses on e-CRM from the five research perspectives. We present a model of e-CRM in terms of the five research areas and how they affect processes and outcomes. Lastly we propose our research agenda for e-CRM and present research questions in e-CRM and an integrated approach for examining those questions".

S. C. Siva Kumar (2003) in this paper he is reviewing the features and the services offered by some of the protocols as proposed by the Internet Engineering Task Force (IETF) with respect to their effectiveness in enabling customer interaction, and derive an IETF based protocol suite that may be used in an e-CRM system. "A modern enterprise needs to interact with customers anytime, anyhow and anywhere to be successful in the global marketplace. This level of customer interaction has become possible due to the advancements in network infrastructure and the simultaneous development of voice and multimedia protocols for seamless transport of information. Instant and unified messaging extends this capability to enable customer touch point integration".

Part I of this paper "provided a critical analysis of the metrics for customer interaction in an electronic customer relationship management (e-CRM) system from customer, business and technology viewpoints. Based on this analysis, this paper reviewed the features and the services offered by some of the protocols as proposed by the Internet Engineering Task Force (IETF) with respect to their effectiveness in enabling effective customer interaction, and derive an IETF based protocol suite that may be used in an e-CRM system".

Jerry Fjermestad et al (2003) Electronic Customer Relationship Management (e-CRM) has become the latest paradigm in the world of Customer Relationship Management. "Recent business surveys suggest that up to 50% of such implementations do not yield measurable returns on investment. A secondary analysis of 13 case studies suggests that many of these limited success implementations can be attributed to usability and resistance factors. The objective of this paper is to review the general usability and resistance principles in order build an integrative framework for analyzing e-CRM case studies. The conclusions suggest that if organizations want to get the most from their e-CRM implementations they need to revisit the general principles of usability and resistance and apply them".

"The integrated e-CRM framework provides a guideline for systems designers and the corresponding management team to improve usability and reduce resistance. In many cases, focusing on usability can reduce resistance (training and educating users) and focusing on resistance can improve usability (use of pilot programmes and prototyping.) These two strategies go hand-in –hand. The organizations that had limited success in implementing e CRM did not initially realize how much of an effect people could have on system success". The key reasons for successful e-CRM implementations, from the analysis, were that the organizations focus was on people and integrative, incremental approaches. By applying the basic usability and resistance principles proposed in this framework, organizations should achieve higher levels of success.

e-CRM is a very complex combination of technology, people, and business processes. In order to get the most out of an implementation it is recommended that the systems designers and implementation managers design for usability and know how to manage, reduce, and overcome resistance.

Nicholas C. Romano (2001) in this paper, "the authors discussed about the electronic Customer Relationship Management (e-CRM) from the perspective of five research areas. The purpose is to define a conceptual framework to examine the relationships among and between these five researches areas within e-CRM and to propose how they might be integrated to further research this area. Discussing of each of the research areas through brief reviews of relevant literature for each and a discussion of the theoretical and strategic implications associated with some e-CRM technologies and research areas. Presented the framework, which focuses on e-CRM from the five research perspectives and a theoretical framework for e-CRM in terms of the five research areas and how they affect one another, as well as e-CRM processes and both performance and non-performance outcomes".

YiHua Phillip Sheng (2002) with the just-a-click-away competition in today's e-era, to better understand firm's customers and serve them correspondently is one of the key factors for business success. Customer Relationship Management (CRM) emerges quickly in recent years under this circumstance. Despite its popularity, there is still a significant failure rate of CRM implementation projects. Reducing more inefficiency in the whole business process has become more and more difficult for companies after growth point. A good demand chain management involves excellent customer relationship management (CRM). Excellent CRM helps companies identify highly profitable customers and then do smart business around them to obtain high return Also, an excellent CRM holds a company and its customers closer than ever to achieve a higher level of intimacy so that long-term loyalty and trust are engendered. In one word, CRM helps companies do business effectively.

CRM converts a company from product-centric to customer-centric. It is highly possible that the CRM initiative would bring changes towards organizational culture, organizational structure, etc. during the implementation and after, because investing in CRM without a customer-oriented culture mindset is pretty much like wasting money.

Internet provides ubiquitous access to the customer information and product information to firms and their customers. e-CRM takes the traditional CRM into a whole new world of application. Web-based touch point and applications connect companies and their customers from anywhere at any time. Tremendous amount of data and information, which is the soul of CRM, could be provided or collected via Internet for analysis.

CRM itself is not a technological term. Instead, it is a business strategy, technology is the enabler of this strategy; firms which are going to adopt CRM need to set their customer-centric strategy first. Speaking of strategy, the CRM systems should be linked or integrated to enterprise-level ERP/SCM systems to streamline the whole business effectiveness without losing efficiency. ERP/SCM helps to fulfill orders; but CRM is the one, which helps to acquire the orders.

Arun Sharma et al (2002) the web is growing at a dramatic pace and is significantly impacting customer and business market behaviors. As a result, "most firms have started developing marketing strategies for the web. The authors proposed that the web is fundamentally changing, and will continue to change, marketing thought and practice. The paper suggests that the web-based markets of tomorrow may have little resemblance to the markets of today. They discussed the emergence of reverse marketing, customer-centric marketing, effective-efficiency, adaptation, expectation management, marketing process focus and fixed cost marketing in the context of marketing theory and practice. In addition, they also discussed customer behaviors such as co-creation, universal availability, and use of in fomediaries, temporal shifts, open pricing and a move toward bricks to clicks.

Dash and Mishra (2012) this research study is the based on impact of customer relationship management practices on insurance sector in Odisha market. The authors have collected the customers opinions through a structured questionnaire to understand the effectiveness of e-CRM implementation in relation to the companies like AVIVA, LIC of India, ICICI prudential, Birla sun life and Reliance. Here to measure the customer satisfaction by insurers, factor analysis test have been used, and considering the factors of satisfaction. On a global scale a number of insurers are competing and offering the customers a plethora of products. The customers are demanding quick and better service from the service providers. For the insurance companies to survive competition, they have to upgrade the quality, transparency and integrity to acquire and retain customers in long range.

They need a set of offers and the value proposition to be delivered to the target potential customers, which needs a thorough market research to understand the needs of the customers and accordingly launching the products to match with customers expectation. Since the initiation of liberalization, privatization and globalization, successive governments have tried to keep pace with a rapidly changing global scenario. The doors for private participation were opened in a number of sensitive sectors, Insurance being one of them. For the past few decades, insurance was looked upon as a tax-saving investment product. While the opportunity for the players is the huge untapped potential, the challenge is to establish a long-term reputation, also to serve the customers in a sophisticated way by introducing the innovative offerings.

Dr. T.N. Murty et al (2013) presented a paper on e-CRM opportunities and challenges in digital world. In today's world of business and technology we are constantly barraged with a ever-ending series of acronyms; a relative recent addition is a e-CRM. Like many of its predecessors, e-CRM stands for electronic customer relationship management, is a term that is tied to a great deal of hype and establishes a frame work for success. A commitment to true CRM implies the ability to analyze customer data and to use a combination of financial and customer based metrics for decision-making. Fundamentally, CRM concerns attracting and keeping "economically valuable" customers and repelling and eliminating "economically invaluable" ones. The amount of information relevant in CRM processes can only be handled effectively when information technology is applied. Due to the lack of personal contact, CRM is of particular importance in e-Commerce.

Samsudin Wahab (2011) submitted a paper on e-CRM performance in electronic services. **"**It is very important to measure the performance of e-CRM in organization. Not much research has been done to measure the performance of e-CRM in the organization. Previous researcher believe that e-CRM performance should be measured ultimately in terms of customer behaviors since they are the underlying sources of value of current customers in a firm and have the potential to increase the future revenue streams associated with them and those prospective customers." This conceptual paper suggests that customer trust, privacy, usefulness, service quality as the antecedents of electronic customer relationship management performance in electronic services.

Ali Feizbakhsh Tavana et al (2013) the purpose of this article is Electronic Customer Relationship Management and its implementation in Business Organizations. "In recent years due to the advancement of technology and IT and consequently increasing the intensity of competition in the markets; it has been observed that using old marketing methods do not guarantee the life and growth of the organizations. So a new system called "Customer Relationship Management (CRM)" to attract and maintaining customers has been introduced".

"It is in fact a business strategy to strengthen a series of organizational behavior in order to achieve customer satisfaction and profits. As a competitive advantage successful companies are always looking to implement new methods and tools in order to achieve development and continuous improvement. One of these tools is CRM that by the development of technology and communications, today is known as electronic Customer Relationship Management (e-CRM)". Considering the importance of the above topic, in this paper, first the definitions of customer, CRM and e-CRM and then the formation of e-CRM, its implementing framework in the organizations, success key factors in the e-CRM strategy's implementation and finally, the challenges facing e-CRM and how to deal with them are preceded.

Faramarz Sharifi et al (2013) The authors have studied the marketing tasks in a wide range of innovative marketing concepts, tools, methods and practices including marketing efforts in order to win the competition for customers, customer satisfaction is the key to winning this competition. One of the most effective tools of achieving this goal is customer relationship management with the development of technology and communication. with today's electronic customer relationship management (e-CRM) are enumerated the purpose of this safe and profitable relationship management is based on customer value as the company's main asset, This article is an attempt to collect the relevant material, with special emphasis on the impact of the adoption of e-CRM Marketing and the interests of customers, there is a way for businesses and organizations.

A.G. Peshwe (2012) This paper explore "the value of e-CRM, explores its benefits, outlines the focal points to address prior to implementation, outlines potential pitfalls during implementation and ways to avoid, takes a look at recent trends and presents a proven e-CRM success story. Electronic Customer Relationship Management (e-CRM) has attracted the attention of managers and academic researchers for the past several years".

Issues of e-CRM have varied from marketing to information technology. Electronic Customer Relationship Management (e-CRM) has become the latest paradigm in the world of Customer Relationship Management. e-CRM is becoming more and more necessary as businesses take to the web.

Kaylene C. Williams et al (2006) this article examines ten current e-commerce practices and discusses how to fine-tune these practices for increased success and usefulness. "The ten e-commerce practices are: (1) evaluate and maintain customer lifetime value; (2) maximize loyalty and trust; (3) focus on improving the customer experience; (4) get personal; (5) balance online and human interaction; (6) communicate effectively; (7) maintain your website; (8) keep up with pricing, payment trends, and ROI; (9) invest in customer service; and (10) use CRM tools to bring it all together".

The Internet and the Web have grown as e-commerce vehicles for reducing costs, increasing value chain efficiency, building customer relationships, trading information and ideas, strengthening brands, and generating revenues. As e-commerce grows, businesses need to be prepared to meet these changes by upgrading their business rules, practices, and systems.

Alireza Abdolhosseini Khaligh et al (2012) The "objective of this study is to find the relationship between e-CRM effective factors and loyalty and retention factors in order to conduct the Iranian mobile telecom operators to be successful in enhancing Loyalty and retention of their customers in this field. With this Approach, the results of our research shows which Factors are effective and which factors are not in Iranian mobile telecom sector. This study enables the manager of this sector to implement the e-CRM in the best shape and match it with Iranian culture to create more loyalty and retention". The research approach is to appraise the impact of electronic customer relationship management in creating loyalty and retention of customers in Iran mobile telecommunication sector. 200 customers who use Iranian mobile telecom operators' services (Hamrah-e Avval, Irancell, and Taliya) have been asked as respondents in this research.

Fjermestad and Romano (2002) this paper is to review the general usability and resistance principles in order build an integrative framework for analyzing e-CRM case studies. "The conclusions suggest that if organizations want to get the most from their e-CRM implementations they need to revisit the general principles of usability and resistance and apply them. Electronic Customer Relationship Management (e-CRM) has become the latest paradigm in the world of

Customer Relationship Management. Recent business surveys suggest that up to 50% of such implementations do not yield measurable returns on investment. A secondary analysis of 13 case studies suggests that many of these limited success implementations can be attributed to usability and resistance factors".

3.4 High Performance Computing

Jack Dongarra et al (2004) this paper is "an overview of the ongoing academic research, development, and uses of heterogeneous parallel and distributed computing. This work is placed in the context of scientific computing. The simulation of very large systems often requires computational capabilities which cannot be satisfied by a single processing system. A possible way to solve this problem is to couple different computational resources, perhaps distributed geographically".

Heterogeneous distributed computing is a means to overcome the limitations of single computing systems.

1. The "recent availability of advanced-architecture computers has had a significant impact on all spheres of scientific computation. In last 50 years, the field of scientific computing has seen a rapid change of vendors, architectures, technologies and the usage of systems. Despite all these changes the evolution of performance on a large scale however seems to be a very steady and continuous process".

   Two things remain consistent in the realm of computational science: "i) there is always a need for more computational power than we have at any given point, and ii) we always want the simplest, yet most complete and easy to use interface to our resources. In recent years, much attention has been given to the area of Grid Computing. The analogy is to that of the electrical power grid. The ultimate goal is that one day we are able to plug any and all of our resources into this Computational Grid to access other resources without need for worry, as we do our appliances into electrical sockets today. This paper will give an overview of the area of heterogeneous and grid computing".

2. Hardware platforms: Heterogeneous hardware used for parallel and distributed computing always include:

    • Multiple processors;

    • Communication network interconnecting the processors.

Distributed memory multiprocessor systems can be heterogeneous in many different ways, but there is only one way for such a system to be homogeneous. Namely, "all processors in the system have to be identical and interconnected via a homogeneous communication network, that is, a network providing communication links of the same latency and bandwidth between any pair of processors".

But this definition is not complete. "One more important restriction has to be satisfied: the system has to be dedicated, that is, at any time it can execute only one application providing all its resources to this application. We will see later how violation of this restriction makes the system heterogeneous". Homogeneous distributed memory multiprocessor systems are designed for high performance parallel computing and typically used to run a relatively small number

Geoffrey Fox et al (2009) "Infrastructure services (Infrastructure-as-a-service), provided by cloud vendors, allow any user to provision a large number of compute instances fairly easily. Whether leased from public clouds or allocated from private clouds, utilizing these virtual resources to perform data/compute intensive analyses requires employing different parallel runtimes to implement such applications. Among many parallelizable problems, most 'pleasingly parallel' applications can be performed using 'Map Reduce' technologies such as Hadoop, CGL-'Map Reduce', and Dryad, in a fairly easy manner. However, many scientific applications, which require complex communication patterns, still require optimized runtimes such as MPI". We first discuss large scale data analysis using different 'Map Reduce' implementations and then, we present a performance analysis of high performance parallel applications on virtualized resources.

Adrian T et al (1999) High performance scientific computer systems traditionally have been compared using individual job performance metrics. However, such metrics tend to ignore high-level system issues, such as how effectively a system can schedule and manage a varied workload, how rapidly the system can launch jobs, and how quickly it can recover from a scheduled or unscheduled system outage. Yet high-level issues such as these are now among the most important factors in the overall effective performance of a system. This article discusses these issues in some detail and then describes a new performance test, called the "Effective System Performance (ESP)" benchmark, which we are developing to measure system-level performance.

Ye Xiaotao1 et al (2010) HPC is most commonly associated with computing used for scientific research nowadays, which always uses supercomputers and computer clusters. "Cloud computing a relatively recent, builds on decades of research in virtualization, distributed computing, utility computing and more recently networking, web and software service. Cloud computing includes 3 services: SaaS, PaaS and IaaS. The popular general cloud service like EC2 allow users to provision compute clusters fairly and quickly by paying a monetary value only for the duration of the resources. Recently, HPC give rises of the cloud computing for cheaper economic solutions and more enterprises announced their HPC on-demand service. In this paper, some HPC applications (mostly recently) that have been deployed with clouds are also summarized. The possibility of using cloud computing for HPC is illustrated by experiments and more and more application types are well-suited to use cloud"**.**

M.H. Jansen et al (2006) in the nineties, more and more attention was raised for process oriented analysis of the performance of companies. Nowadays, many process aware information systems are implemented (e.g., workflow management systems) and business processes are evaluated and redesigned. "The discipline related to this field of study is called Business Process Management (BPM). An important part of the evaluation of designed and redesigned business processes is Business Process Simulation (BPS). Although an abundance of simulation tools exist, the applicability of these tools is diverse. In this paper we discuss a number of simulation tools that are relevant for the BPM field, we evaluate their applicability for BPS and formulate recommendations for further research".

Volodymyr V. Kindratenko et al (2009) Large-scale GPU clusters are gaining popularity in the scientific computing community. However, their deployment and production use are associated with a number of new challenges. The authors, "present our efforts to address some of the challenges with building and running GPU clusters in HPC environments. We touch upon such issues as balanced cluster architecture, resource sharing in a cluster environment, programming models, and applications for GPU clusters".

Honggao Liu (2005) discussed The Sustainability of High Performance Computing at Louisiana State University Computation is joining theory and experiment as the third pillar of scientific investigation. "It is now recognized around the world as an essential national technology in terms of scientific leadership, economic competitiveness and national security. Computational science the use of advanced computing capabilities to understand and solve today's complex problems in science, engineering and the humanities requires significant advances in hardware, software, algorithms, visualization, as well as the underlying domains".

To "promote scientific computing and technology across all disciplines and enable education, research and discovery through the use of emerging, advanced computational technologies, LSU's Center for Computation and Technology (CCT) and Information Technology Services (ITS) partnered to establish the HPC at LSU in 2005, a central gateway to the high performance computing resources and expertise of LSU. The State of Louisiana has responded to the nation's call for advancing computational science by providing advanced infrastructure to its researchers through the Louisiana Optical Network Initiative (LONI), over 85 T Flops of compute resources connected to each other, and the rest of the nation, via high speed optical networks"**.**

Paul Greenberg (2001), author of the book 'CRM at the Speed of Light' has observed that in the contemporary business, the customer is the controlling force. He gave his opinion that the customers cannot be molded and shaped in accordance to the product. The process has been entirely reversed and has become more of a continuous, real-time process than a fixed plan. The author has explained that "CRM is a complete system that (1) provides a means and method to enhance the experience of the individual customers so that they will remain customers for life, (2) provides both technological and functional means of identifying, capturing, and retaining customers, and (3) provides a unified view of the customer across an enterprise". The CRM system is a complex, constantly shifting almost liquid set of definitions, concepts, and methodologies that change according to the principles of customer real-time demand (in other words, a closed infinite loop) and dramatically shifting market conditions.

V. Venkataramana et al (2003), authors of the book titled 'Customer Relationship Management: A Key to Corporate Success' have observed that CRM as a business strategy has radically transformed the way organizations operate. "There has been a shift in business focus from transactional to relationship marketing where the customer is at the center of all business activity. Organizations are now trying to restructure their processes around the needs of their strategically significant customers. The critical driver of such a significant shift towards customer orientation is the realization that customers are a business asset that when managed effectively can derive continuous and sustainable economic value for an organization over their lifetime. Banks have relationship managers for select customers, airlines have frequent flyer programmes to reward loyal customers, credit card companies offer redeemable bonus points for increased card usage, telecom service operators provide customized services to their heavy users, and hotels have personalized services for their regular guests".

It is, however, with the rapid rise of new entrants into the market place and increased competition that companies in other sectors have recognized the business potential within a captured base. "The authors have also remarked that developments in information technology, data warehousing and data mining have made it possible for firms to maintain good relationships with their customers. Firms can now manage every single contact with the customer from account management personnel, call centers, interactive voice response systems, on-line dial-up applications, and websites to build lasting relationships. These interactions can be used to obtain information and insights about customer needs and their buying behavior to design and develop services, which help create value for the customers as well as the firms. Although customized as well as off the shelf technological solutions are available in the marketplace, businesses need to do a lot more than just adopt these solutions to implement customer relationship management (CRM) practices. CRM offers huge potential benefits but requires a more sophisticated approach adapted to specific opportunities and circumstances".

At the core of any technology enabler for CRM is the customer database. "This represents the data hub that integrates the various statistical modeling, campaign management, contact history and response tracking components of the marketing campaign life-cycle. The technology layer and its integration with emerging business processes is therefore the key to successful implementation of a data-driven customer relationship management".

Stephen Smith et al (2000), authors of the book titled "Building Data Mining Applications for CRM" have observed that the way in which companies interact with their customers has undergone a radical transformation over the years. "A customers continuing business is no longer guaranteed, as a result, companies have found that they need to understand their customers better, and to quickly respond to their wants and needs. In addition, the time frame in which these responses need to be made has been shrinking. It is no longer possible to wait until the signs of customer dissatisfaction are obvious before action must be taken. To succeed, companies must be proactive and anticipate what a customer desires".

A huge increase in the number of customers, products, competitors, and means that understanding the customers is much harder. A successful company needs to reinforce the value it provides to its customers on a continuous basis. In addition, the time gap between the formation of a new desire and the time required to satisfy that desire is also shrinking. A technology input like data mining can help solve complex issues in managing companies' interactions with their customers. Data mining, by its simplest definition, automates the detection of relevant patterns in a database. Data mining uses well-established statistical techniques to build models that predict customer behavior.

3.5 Summary

The literature provided the good amount of information pertaining to financial, conceptual and theoretical aspects of High Performance Computing and e-CRM and interaction of both.

The extensive analysis of logs, profiles also have been carried out it's seem to be there is a gap in carried out the opinion analysis and it's considering e-CRM of such facility. This study aim at compiling data about the users and their opinions and aspirations as a first step for further this is desired to take the CMSD and its users as the premises of study.

4 Research Methodology

4.1 Need for study

Higher education, today, is undergoing a sea change at an enormous speed. Worldwide, Educational institutions are undergoing basic shifts in the way they operate and communicate with their "customers": students, alumni, faculty members, and staff members. It is not just the quality of knowledge generated with higher educational institutions and its availability to wider economy is critical, but also how an institution does it. New technology-based tools for gathering and disseminating knowledge have become central element of today's education system. Various factors live technology growth cost effective communication, high mobility, rise in quality of life are posing challenges, in various sectors of mankind and so in education.

The growth in technology, cost effective, , communication, high mobility, rise in quality of life pose challenges, in various sectors of mankind including education. The dynamic changes need to be understood for making better decisions through management of education systems. To meet the objective and aspirations of the students, researchers and the society, mere technology dose not suffice. It is also essential to intervene with an apt management strategy more in as e-CRM treating the students, researchers (users) and society as customers of the education system. e-CRM tools will aid in deriving useful, feasible and admissible information. Fast changing technological, economic, sociological, and governmental forces are altering education and the way it is managed, impacting institutions, teachers, students, funding sources, and society.

4.1.1 Scope of Study

The scope of the study is restricted to understand the aspirations, satisfaction levels, and infrastructural management issues pertaining to High Performance Computing Facility (very limited facilities due to the cost and maintainability aspects). The study is on high performance computing and supercomputing facilities, which are very costly, very advance system with well maintained, 24x7 high availability. It needs highly skilled professionals to maintain such systems, available in limited manner, to the users, and such facilities are essential to bring out high quality and impacting research out comes as well as developing the human resources (skilled manpower).

The study aims to investigate the impact of the electronic customer relationship management on customer satisfaction. The usage of the computing facilities has increased in many folds; It is very difficult for the High performance computing and supercomputing facilities to manage and satisfy the Customers (Users). Therefore the research studies, the implementation of e-CRM at Center for Modelling Simulation and Design, a High Performance Computing Facility at University of Hyderabad.

4.2 Objectives of the Study

The primary objective of the study is conceptualizing e-CRM strategies in service sector like High Performance Computing facilities. HPC and supercomputer facilities have major three aspects,

1. Computer Systems
2. Application Software
3. Skilled professionals.

The users are customers of the HPC to submitting their jobs to application software on a platform by taking the assistance of skilled professionals, if needed. The performance of the above three components will have an impact on customer satisfaction.

The Specific Objectives of the Study are as follows:

1. What is the impact level of software packages availability on customer satisfaction?
2. What is the impact level of accessibility of the facility on customer satisfaction?
3. What is the impact level of usage of facility on customer satisfaction?
4. What is the impact level of personalization on customer satisfaction?

5. What is the impact level of fulfillment of requirements on customer satisfaction?

4.2.1 Problem Definition

Impact of e-CRM on Customer Satisfaction in HPC environment

Research Questions

- In the context of HPC facility it is quite important to assess customer satisfaction with respect to the following factors:
- Availability of software packages
- Accessibility to the facility
- Level of usage
- Level of personalization
- Fulfillment of requirements

4.3 Methodology and Analysis of the Study

4.3.1 Research Methodology

Explorative and Descriptive research methodologies are adopted. "An exploratory study was carried out to address a problem suited to more precise investigation. Exploratory studies help in understanding and assessing the critical issues of problems. Exploratory research studies are used for subsequent research to attain conclusive results for a particular problem-situation. Exploratory studies are conducted to analyze a problem situation, to evaluate alternatives and to discover new ideas".

The data collection strategy that been adopted for the current study is a combination of multi data collection techniques and methods. Empirical data from secondary survey questionnaires offer possible experiences, explanations and the requirements. It is proposed to study the High Performance Computing Facility at Center for Modelling Simulation and Design, University of Hyderabad.

Yin (2003) defines the research design as guiding the investigator in the process of collecting, analyzing and interpreting observation. The process of combining data collection techniques is known as "triangulation" (McGrath 1982), or the use of several kinds of method or data. By conducting a variety of data gathering methods, an addition of rigor, breadth and depth to research or study investigation takes place effectively within the research frame designed (Flick, 1992). This could be done by integrating rich detailed data resulted from questionnaire survey with the flexibility of getting information from using other research methods or techniques such as personal interviews, focus group historical and empirical data, pilot study, etc. (Gummeson 1991, Yin 1994).

4.3.2 Research Process

The process of research can be performed in many ways like Exploratory Research, Descriptive Research, and Explanatory Research. The common things in all these researches are they perform a sequence of activities which are interrelated and combined to form a research process". According to Zikmund (2000), "it is not necessary that all the researches follow the same order but it is necessary to describe a common pattern for all the researches. The process of research is a repeating process or a cyclical process because the final conclusions after the complete study may again generate new ideas and problems which again need to be investigated" (Zikmund 2000). The author feels that the process of research will not follow a sequential order but it is important that all the researches must follow a similar pattern.

4.3.3 Types of Research

According to Eriksson and Widersheim-Paul (1982), the three types of research are explained in brief which is as follows:

•Exploratory Research

•Descriptive Research

•Explanatory Research

1. Exploratory Research: "The main aim of this research is to define various questions and hypothesis based on the nature of the problem. Its main purpose is to provide a better understanding and not to provide convincing facts. According to Yin (1993), this type of research is conducted with the hope that a consequent research of similar type will proceed. Exploratory researches are applied when the data collected about a particular problem is not clear".

2. Descriptive Research: "The main aim of this research is to describe something like the population or phenomena. It is mainly used as an antecedent for an exploratory research to get a better phenomenon. It aims to answer the questions like what, where, who and how. The main thing to be focused on descriptive research is that it does not answer to why questions. It means it does not give a proper explanation for the cause of findings" (Eriksson and Widersheim-Paul, 1982). While performing descriptive research the researcher must be aware of the problem situation i.e. research problem.

3. Explanatory Research: "The purpose of this research is to identify the cause and relationships between the variables. To perform this research, researcher must have enough knowledge about the subject that is to be investigated. According to Zikmund (2000), the researches that are

executed first are Exploratory and Descriptive researches, then causal research is executed to explain that when one thing is done the other thing will follow. The main purpose of this research is to get a very clear understanding on the usage of CRM".

4.3.4 Research Strategy

There are basically five research strategies. They are "Surveys, Experiments, Histories, Case studies and Archival analysis" (Yin, 1994). There are three conditions on which each strategy focuses and they are as listed below:

1. By focusing on contemporary events.
2. The type of research questions to be posed.
3. The control that an investigator has on behavioral events (Yin, 1994).

"The different techniques that are followed to perform a research are Experience study, Secondary Data analysis, Case Study and Pilot Study (Zikmund, 2000) which are discussed as follows":

Experience study: "In this study, all the individuals who are knowledgeable about a research problem are surveyed. This study helps to clarify the concepts".

Secondary Data analysis: "To clarify the issues of the research in an early stage and Data analysis is like the review of data that is gathered for some other purpose (Zikmund, 2000)".

Case Study: "In this study, few situations similar to researcher's problem are investigated. The main advantage with the case study is that an organization or entity can be investigated in depth".

Pilot Study: This study makes use of sampling techniques.

"The most appropriate approach for research strategy is the Case Study Technique because it helps the researchers to analyze and study several aspects in detail".

4.3.5 Research Approaches

According to Holme and Solvang (1991), there are two types of research approaches to conduct a research:

- Quantitative Research Approach
- Qualitative Research Approach

4.3.5.1 Qualitative Research Approach

Qualitative data means the soft data like the atmosphere at work. This research gathers, interprets and analyses the data that cannot be quantified. It is implemented to give a complete understanding on the information gathered and the problem that is studied. "Qualitative Research mainly concerns about the qualitative phenomena that is the phenomena related to the quality. Qualitative research methods include a process which mainly concentrates and understands the problem from various resources. It means that researcher study the things in their natural settings and attempt to make sense to the research by taking suggestions from the people. This research includes case study, interviews, historical, and from visual texts. In order to organize the fields the qualitative researchers have offered several topologies (Catherine Marshall and Gretchen B. Rossman, 2006). Qualitative research takes place in the natural world, and includes many features like it focuses on context, uses multiple methods which are interactive and humanistic, fundamentally interpretive, etc."

4.3.5.2 Quantitative Research Approach

Quantitative data means the hard data like the information on the profits gained. "This approach treats the problem of research in a particular point of view. The results of this approach are measurable and depicted in figures. A Quantitative Research is controlled by the researcher where only a few variables are studied on a large number of entities (Holme and Solvang, 1991)". "This research is applicable to the phenomena that are mainly expressed in terms of quantity. It is the process in which the inquiry is done in an identified problem. The inquiry is done based on testing the theory composed of variables, measured with numbers and analyzed using the statistical techniques. In these techniques it uses numbers and statistical methods (Mark Balnaves and Peter Caputi, 2001)".

4.4 Analysis of the Data

4.4.1 Primary Data

To carryout the study a questionnaire has been designed (Appendix-I). The primary data has been collected by administrating the questionnaire, user logs at server level, interviews with a cross section of respondents including faculty, researchers and students (users/customers of High Performance Computing Facility at University of Hyderabad).

This method of data collection is quite popular, particularly in case of big enquiries. It is being adopted by private individuals, research workers, private and public organizations and even by governments. In this method a questionnaire is sent by email and in person to the persons concerned with a request to answer the questions and return the questionnaire. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. The questionnaire is emailed to respondents who are expected to read and understand the questions and select answers from multiple choices or reply in the space meant for the purpose in the questionnaire itself. The respondents have to answer the questions on their own. The method includes collecting data by mailing the questionnaires and in some cases personal interviews also conducted with the respondents, at their convenient time. The Data is coded and classified to convert the questionnaires to digital data to be used in the SPSS package.

4.4.2 Sample Selection

Sampling methods are classified as either probability *or* non-probability. In probability samples, each member of the population has a known non-zero probability of being selected. Probability methods include random sampling, systematic sampling, and stratified sampling. In non-probability or purposive sampling, members are selected from the population in some non-random manner. These include convenience sampling, judgment sampling, quota sampling, and snowball sampling. The advantage of probability sampling is that sampling error can be calculated. Sampling error is the degree to which a sample might differ from the population. When inferring to the population, results are reported plus or minus the sampling error. In non-probability or purposive sampling, the degree to which the sample differs from the population remains unknown.

Probability Sampling

Simple random sampling: The simplest form of random sampling is called **simple random sampling**. In this we select participants from a given population such that each participant in the population has an equal chance of being selected. If number of participants is large (1000) true random selection will produce a participant group with very similar demographic features to the total population from which it is selected. A randomly selected sample of 1000 will have no more than a 5% margin of error when used to predict categorical characteristics of a population.

Systematic sampling is often used instead of random sampling. It is also called a N^{th} name selection technique. After the required sample size has been calculated, every N^{th} record is selected from a list of population members. As long as the list does not contain any hidden order, this sampling method is as good as the random sampling method. Its only advantage over the random sampling technique is simplicity. Systematic sampling is frequently used to select a specified number of records from a computer file.

Stratified Random Sampling involves dividing the population into homogeneous subgroups based on one factor and then taking a simple random sample in each subgroup.

Quota Sample In this case also, the entire population is first divided into homogeneous sub-groups with respect to the given characteristic such as culture. Then, a specified number of people from each stratum or selected rather than selecting them through random procedure. The resulting samples are called quota samples.

Purposive Sampling

Purposive sampling starts with a **purpose in mind** and the sample is thus selected to include people of interest and exclude those who do not suit the purpose. Subjects are selected because of some characteristic. Purposive sampling is popular in qualitative research.

As the research was focused on impact of e-CRM on customer satisfaction in service areas, the following sectors were chosen, keeping in view of the facts revealed in literature survey.

The High Performance Computing (HPC) facility in Universities is recent concept and it is very expensive. The HPC cannot deployed and put use wherever and whosoever wants. It needs a specialized and skilled professional with adequate exposure to system. As this population of users is very small relative to any other service providing systems, it has been decided to adopt a simple random sample technique to select the respondents.

4.4.3 The Specifications of the Sample

Among the existing High Performance Computing centers in India, the users of University of Hyderabad High Performance Computing facility in Center for Modelling Simulation and Design Lab have been selected as representative cluster of the population. The users of this center are Faculty, Researchers' and students.

A simple random sampling has been employed for selecting from each category (faculty, researchers and students).

4.4.4 Questionnaire

A questionnaire is designed, to capture the data from the respondents (enclosed in Appendix-I). The responses are collected by personal Interview.

4.4.5 Data Organization

The raw data obtained from the questionnaires must undergo preliminary preparation before they can be analyzed using statistical techniques. The quality of the results obtained from the statistical techniques and their subsequent interpretation depend to a great degree on how well the data were prepared and converted into a form suitable for analysis. The major data preparation techniques include (1) data editing, (2) coding, and (3) statistically adjusting the data (if required).

The collected responses are codified and labeled to use the data by the SPSS Package. Data entered in excel format and the imported to SPSS v 22.0 Package.

4.4.6 Data Sample

The total users at the center are around 800. 173 research scholars, 58 faculty members and 60 students (of various PG courses) constituted the sample.

4.4.7 Data Analysis

Usually the first step in data analysis, after data preparation, is to analyze each question or measure by itself. "This is done by tabulating the data. Tabulation consists of simply counting the number of cases that fall into the various categories. Other than aiding in "data cleaning" aspects, such as identifying the degree of omissions, ambiguities, and errors in the responses, the primary use of tabulation is in (1) determining the empirical distribution (frequency distribution) of the variable in question and (2) calculating the descriptive (summary) statistics, particularly the mean or percentages".

Next, the data are subjected to cross-tabulations to assess if any association is present between two (typically) nominal variables. If the variables are measured as interval or ratio, they are transformed to nominally scaled variables for the purpose of cross-tabulation. For analyzing relationships between two or more variables, multivariate analysis can be performed.

SPSS Package was used to compile and analyze the data collected from the field survey. Frequency distribution was studied to gather the first hand information on various variables.

SPSS Scripts have been developed for analyzing the data.

1. The frequency tabulation for understanding the composition of the sample.
2. A cross-tabulation and chi-square association test for eliciting the association among the attributes in the questionnaire.

4.5 Summary

This chapter presented, the overview of the research methodology, including the sampling process. The Center for Modelling Simulation and Design (CMSD) of University of Hyderabad which is a one of the High Performance Computing Facility (HPCF) is considered as a representative unit and the users as sampling units. A questionnaire is designed (Appendix -I) and administrated among the sampling units which resulted in the primary data. The data extracted out from logs is considered as secondary data pertaining to the users. The data was coded into SPSS.

5 Data Analysis

5.1 Data Analysis Techniques

Data has been analyzed using statistical such as ANOVA, Chi-square test, Spearman's Rank Correlation, Regression analysis, Factor analysis and simple statistics such as average and mean. SPSS is used to facilitate the same.

5.1.1 ANOVA Test

The analysis of variance, popularly known as the ANOVA test is used in cases when there are more than two groups. "Analysis of variance (ANOVA) is a statistical technique that can be used to evaluate whether there is a differences in the average value or mean, across several population groups. With this model, the response variable is continuous in nature whereas the predictor variables are categorical". When there are only two samples one can use the t-test to compare the means of the samples but it might become unreliable in case of more than two samples. If only two means are compared, then the t-test (independent samples) will give the same result as the ANOVA. It is used to compare the means of more than two samples. "In statistics, analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes t-test to more than two groups. ANOVA's are helpful because they possess an advantage over a two sample t-test. Doing multiple two-sample t-test would result in an increased chance of committing a type-I error. For this reason, ANOVA's are useful in comparing three or more means".

The purpose of ANOVA test is to determine the existence, or absence of a statistically significant difference amongst several group means. ANOVA actually uses variances to help determine if the various means are equal or not.

To perform ANOVA test three basic assumption must be fulfilled.

- Each group which the sample is taken is normal
- Each group is randomly selected and independent.
- The variables from each group come from distribution with approximately equal standard deviation.

One-way ANOVA: One way ANOVA is used when there is only one category whose effect has been studied and balanced. Thus the basic idea is to test whether the samples are all alike or not. "One-way ANOVA evaluates the effect of a single factor on a single response variable. Using ANOVA to make this comparison requires that several assumptions be satisfied. Specifically the sample must be selected randomly from each of the population groups, a value for the response variable is recorded for each sampled respondent, the distribution of the response variable is normally distributed in each population, and the variance of the response variable is the same in each population". As indicated through its designation, ANOVA compares mean by using estimates of variance. Specifically, the sampled observations can be described in terms of the variation of the individual values around their group means, and of the variation of the group means around the overall mean. These measures are frequently referred to as source of "within groups" and "between groups" variability, respectively. If the variability within the *k* different population is small relative to the variability between the group means, this suggests that the population means are different". This is formally tested using attest of significance based on the *F* distribution, which test the null hypothesis (Ho) that the means of the *k* groups are equal.

$Ho = \mu 1 = \mu 2 = \mu 3 = \ldots.. \mu k$

An "*F*- test is constructed by taking the ratio of the "between-groups" variation to the "within-groups" variation. If *n* represent the total number of sampled observations, this ratio has an F distribution with *k-1* and *n-k* degrees in the numerator and denominator, respectively. Under the null hypothesis, the within-groups and between-groups variance both estimate the same underlying population variance and the F ratio is close to one. If the between-groups variance is much larger than the within-groups, the F ratio become large and the associated *p-value* becomes small. This lead to rejection of the null hypothesis, thereby concluding that the means of the groups are not all equal. When interpreting the results from the ANOVA procedures it is helpful to comment on the strength of the observed association, as significant differences may result simply from having a very large number of samples".

5.1.2 Chi-Square test

The chi-square (I) test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. The chi-square is one of the most popular statistics because it is easy to calculate and interpret. There are two kinds of chi-square tests. The first is called a one-way analysis, and the second is called a two-way analysis. The purpose of both is to determine whether the observed frequencies (counts) markedly differ from the frequencies that we would expect by chance.

A "chi-square test (also chi squared test or χ^2 test) is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true, or any in which this is asymptotically true, meaning that the sampling distribution (if null hypothesis is true) can be made to approximate a chi-square distribution as closely as desired by making the sample size large enough". The chi-square (χ^2) test measures the alignment between two sets of frequency measures. These must be categorical counts and not percentages or ratios measures (for these, use another correlation test).

Goodness of fit: A common use to assess whether a measured/observed set of measures follows an expected pattern. The expected frequency may be determined from prior knowledge (such as previous year's exam results) or by calculation of an average for the given data. The null hypothesis, Ho is that the two sets of measures are not significantly different.

Independence: The chi-square test can be used in the reverse manner to goodness of fit. If the two sets of measures are compared, then just as you can show they align, you can also determine if they do not align. The null hypothesis here is that the two sets of measures are similar. The main difference in goodness-of-fit vs. independence assessment is in the use of the Chi Square table.

5.2 Frequency Analysis

The section consists of Frequency analysis and interpretation that is facilitated SPSS package. The analysis is presented findings, analysis and interpretation responses of the community under the study. The section is presented using tables; charts and interpretation which are drawn in the light of the findings.

5.2.1 Frequency Table

Table 1: Designation Organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	UNIVERSITY OF HYDERABAD	335	85.2	85.2	85.2
		58	14.8	14.8	100.0
		393	100.0	100.0	

Table 2: Designation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Research Scholar	173	44.0	44.0	44.0
	Faculty	159	40.5	40.5	84.5
	Student	61	15.5	15.5	100.0
	Total	393	100.0	100.0	

One can notice from the table that 80% user are using from the workplace or home rather than coming to the center. This is essential component for needing of current day needs. In this regard the infrastructure should be sophisticated seamless virtual activities. Further management challenges possess specific to virtual support, virtual guidance and training for this purpose the skilled professional of HPC should also develop skills to exhibit their support to remote user also.

Table 3: Field of Research

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	School of Mathematics and Statistics	32	8.1	8.1	8.1
	School of Physics	92	23.4	23.4	31.6
	School of Chemistry	128	32.6	32.6	64.1
	School of Life Sciences	108	27.5	27.5	91.6
	School of Engineering Sciences and Technology	21	5.3	5.3	96.9
	School of Economics	4	1.0	1.0	98.0
	School of Computer and Information Sciences	8	2.0	2.0	100.0
	Total	393	100.0	100.0	

The school of chemistry are having the 32.6%, school of life science are 27.5% school of physics 23.4% other schools are having the single digit percent. It shows that the users are more acquainted with HPC systems.

Table 4: Group of Software Packages Used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Software Packages- Chem-Life Sciences	236	60.1	65.4	65.4
	Software Packages- Chem/Physics/Life Science	67	17.0	18.6	83.9
	Engg and Earth Science	54	13.7	15.0	98.9
	Economics Software	4	1.0	1.1	100.0
	Total	361	91.9	100.0	
Missing	None	32	8.1		
Total		393	100.0		

The usage of software packages used by the schools of chemistry and school of life sciences are form the 60.1% and other software packages less than 20%.

Table 5: Year of Register

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2003	108	27.5	27.5	27.5
	2004	64	16.3	16.3	43.8

	2005	37	9.4	9.4	53.2
	2006	62	15.8	15.8	69.0
	2007	29	7.4	7.4	76.3
	2008	25	6.4	6.4	82.7
	2009	37	9.4	9.4	92.1
	2011	31	7.9	7.9	100.0
	Total	393	100.0	100.0	

Table 6: Use of Linux Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Linux	288	73.3	100.0	100.0
Missing	None	105	26.7		
Total		393	100.0		

Table 7: Use of AIX Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AIX	176	44.8	100.0	100.0
Missing	None	217	55.2		
Total		393	100.0		

Table 8: Purchase Time from Scientific Computing Centers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Purchase Time from Scientific Computing Centers	82	20.9	100.0	100.0
Missing	None	311	79.1		

Total		393	100.0		

From the above tables the registrations of user are reducing trend, it may be because of the awareness of HPC facility uses and advantages, it needs to conduct the workshops/training program about the HPC facility and its importance. The users are having the Linux and AIX platform operating system. The 20% users are still purchasing the system time from the outside the center. It indicating to the HPC facilities needs to upgrade its facility to attract the users.

Table 9: Need of Continuous Resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Need of Continuous Resources	263	66.9	100.0	100.0
Missing	None	130	33.1		
Total		393	100.0		

Table 10: Resources on Demand

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Resources on Demand	64	16.3	100.0	100.0
Missing	None	329	83.7		
Total		393	100.0		

Table 11: Technical Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Technical Support	130	33.1	100.0	100.0
Missing	None	263	66.9		
Total		393	100.0		

Table 12: Application Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Application Support	253	64.4	100.0	100.0
Missing	None	140	35.6		
Total		393	100.0		

From the above frequency tables shows that, the 2/3rd of the users are in the need of continue resources require the 24x7 availability and 16% of the users requires on resources on demand availability. The 1/3rd of the users badly needs the technical support and 2/3rd needs the application support. The above findings, if there are properly address through e-CRM strategies it expected that the impact rating will enhance.

Table 13: Computational Projects Planning and Implementation Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Computational Projects Planning and Implementation Support	121	30.8	100.0	100.0
Missing	None	272	69.2		
Total		393	100.0		

Table 14: Importance of Security of Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Security of Data Important	195	49.6	100.0	100.0
Missing	None	198	50.4		
Total		393	100.0		

Table 15: Unreliability of the System (Crashes)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unreliability of the System(Crashes)	125	31.8	100.0	100.0
Missing	None	268	68.2		
Total		393	100.0		

Table 16: Long queuing time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Long queuing time	109	27.7	100.0	100.0
Missing	None	284	72.3		
Total		393	100.0		

Table 17: Substandard or missing technical support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Substandard or missing technical support	98	24.9	100.0	100.0
Missing	None	295	75.1		
Total		393	100.0		

From the tables it shows that, the only 30% are provided with project planning and implementation support. It needs to improve by the HPC facility management. The 50% of the users are provided the security to the data. This also needs to address to improve. There are a 1/3rd of the users experiencing the system crashing. The 25% of the users are feeling that the technical support is not adequate. The 27% of the users are experiencing the jobs having the long queue. Some important, which are not availability of software requires.

Table 18: Long Support response time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Long Support response time	111	28.2	100.0	100.0
Missing	None	282	71.8		
Total		393	100.0		

Table 19: Too much time spent on Support issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too much time spent on Support issues	103	26.2	100.0	100.0
Missing	None	290	73.8		
Total		393	100.0		

Table 20: Supercomputing Resource

		Freque ncy	Percent	Valid Percent	Cumulative Percent
Valid	Additional RAM	78	19.8	21.8	21.8
	Additional Disk Space	44	11.2	12.3	34.2
	More Time allocation	40	10.2	11.2	45.4
	Block Time	25	6.4	7.0	52.4
	Reservation of Resources	94	23.9	26.3	78.7
	Better Network Connectivity	24	6.1	6.7	85.4
	Updated software	52	13.2	14.6	100.0
	Total	357	90.8	100.0	
Missing	None	36	9.2		
Total		393	100.0		

Table 21: Frequency of Job Submission

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	193	49.1	49.1	49.1
	Weekly	200	50.9	50.9	100.0
	Total	393	100.0	100.0	

Table 22: Use of HPC

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	183	46.6	46.6	46.6
	Weekly	174	44.3	44.3	90.8
	Monthly	30	7.6	7.6	98.5
	Rarely	6	1.5	1.5	100.0
	Total	393	100.0	100.0	

Table 23: Job Submission Process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	93	23.7	23.7	23.7
	Satisfactory	195	49.6	49.6	73.3
	Moderate	69	17.6	17.6	90.8
	Complex	36	9.2	9.2	100.0
	Total	393	100.0	100.0	

From the above frequency tables it indicates that the users not getting immediate response in and in the support related issues the 50% of the users are satisfied around 24% are excellent. The users responded for increase in reservation of resources, additional RAM, additional Disk space and update the software. The job submission process should make elegant to enhance user capture and comfort is to executed, and increases percent to the excellent.

Table 24: Nature of the Job

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Parallelizable	158	40.2	40.2	40.2
	Serial	13	3.3	3.3	43.5
	Both	222	56.5	56.5	100.0
	Total	393	100.0	100.0	

Table 25: Security of Job

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	181	46.1	46.1	46.1
	Excellent	212	53.9	53.9	100.0
	Total	393	100.0	100.0	

Table 26: Security of the Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	219	55.7	55.7	55.7
	Excellent	174	44.3	44.3	100.0
	Total	393	100.0	100.0	

The above frequency tables show that the job of serial type is less than 5%. It means that the purpose of HPC facility is met. The purpose of High Performance computing facilities are to use for high end number crunching and parallel jobs. The 50% user are requires the security for job and data.

5.3 Qualitative Analysis:

Responses of the users input the categorical items of questionnaire like designation, organization have been considered for understanding the association characters for example the null hypothesis designation as independent of the organization of user against the designation and organization are dependent among the responders.

H0 – Attributes are independent.

H1 – Attributes are dependent

A chi-square computing analysis has been employed for investigating on control of give the two chances to the responder, absent of the data is provided in the following table the sub sections provide some of the selected statistical significant pair of attributes and its inference.

Designation * Field of Research

Table 27: Designation vs Field of Research

			Field of Research							Total
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	
Designation	Research Scholar	Count	0	45	70	42	4	4	8	173
		Expected Count	14.1	40.5	56.3	47.5	9.2	1.8	3.5	173.0
	Faculty	Count	22	37	40	48	12	0	0	159
		Expected Count	12.9	37.2	51.8	43.7	8.5	1.6	3.2	159.0
	Student	Count	10	10	18	18	5	0	0	61
		Expected Count	5.0	14.3	19.9	16.8	3.3	.6	1.2	61.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	55.240[a]	12	.000
Likelihood Ratio	72.136	12	.000
Linear-by-Linear Association	2.086	1	.149
N of Valid Cases	393		

a. 8 cells (38.1%) have expected count less than 5. The minimum expected count is .62.

The above Table-29 exhibits highly statistically significant dependency (p-value =0.000) between the field of research and designation indicating the rejection of null hypothesis i.e. field of research and designation are associated.

H0 – field of research and designation are independent.

H1 – field of research and designation are dependent

From the Table-29 it is clearly can be notice that the School of Mathematics and Statistics research scholars not using and mathematics faculty are more others are same as expected.

The chi-square test indicates that highly statistically significant. Hence it is concluded that field of research and designation are associates.

The effective e-CRM for satisfactory motivate and entrust in access the disciplines and designations.

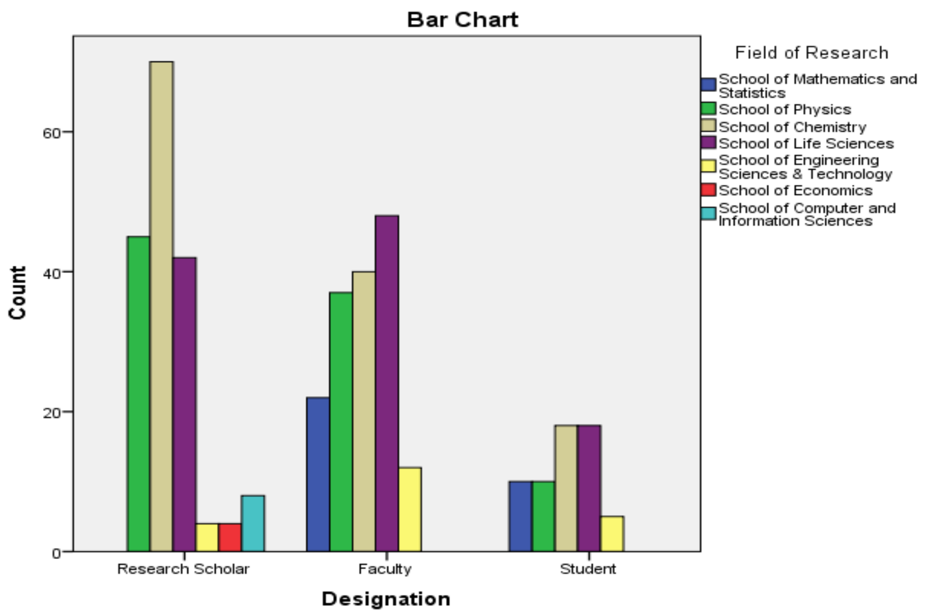


Figure 1 Designation vs Field of Research

User's proportion is significant in the designation and field of research. The Schools of Chemistry and School of Computer Information Sciences research scholars are using more. While School of Mathematics and Statistics and School of Engineering Sciences and Technology research scholars are using less than expected. Even the Mathematics faculty is turnout to be more than expected.

Designation * Group of Software Packages Used-2

Table 28: Designation vs Group of Software Packages Used-2

	Group of Software Packages Used				
	Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/ Life Science	Engg and Earth Science	Economics Software	Total

Designation	Research Scholar	Count	112	53	4	4	173
		Expected Count	113.1	32.1	25.9	1.9	173.0
	Faculty	Count	88	14	35	0	137
		Expected Count	89.6	25.4	20.5	1.5	137.0
	Student	Count	36	0	15	0	51
		Expected Count	33.3	9.5	7.6	.6	51.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.679[a]	6	.000
Likelihood Ratio	85.361	6	.000
Linear-by-Linear Association	3.617	1	.057
N of Valid Cases	361		

5.1 3 cells (25.0%) have expected count less than 5. The minimum expected count is .57.

The above Table-30 exhibits highly statistically significant dependency (p-value =0.000) between the Group of Software Packages used-2 and designation indicating the rejection of null hypothesis i.e. Group of Software Packages used-2 and designation are associated.

H0 – Group of Software Packages used-2 and designation is independent.

H1 – Group of Software Packages used-2 and designation are dependent

From the above Table-30 it is found that the Research Scholars of School of Chemistry, Physics and Life Sciences are using Packages more than the expected.

The Designation and the Group of Software Packages used-2 is significant. The faculty is using the above group of software packages as expected. The research scholars are using the other software packages as expected.

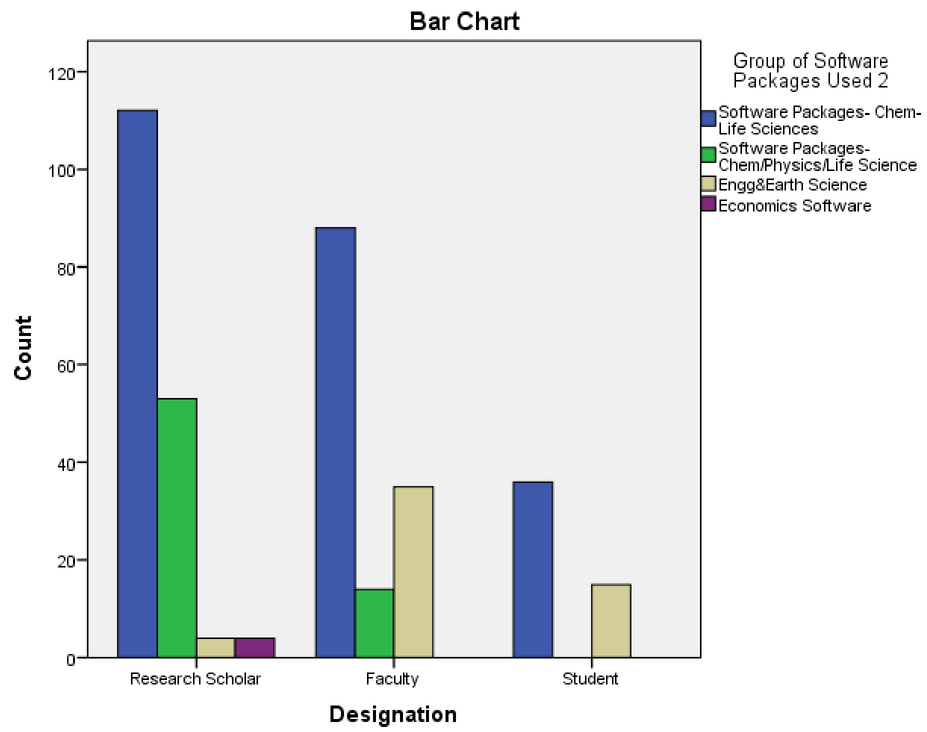


Figure 2 Designation vs Group of Software Packages Used-2

Designation * Year of Register

Table 29: Designation vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Designation	Research Scholar	Count	2	49	0	59	0	4	32	27	173
		Expected Count	47.5	28.2	16.3	27.3	12.8	11.0	16.3	13.6	173.0
	Faculty	Count	74	15	23	3	14	21	5	4	159
		Expected Count	43.7	25.9	15.0	25.1	11.7	10.1	15.0	12.5	159.0
	Student	Count	32	0	14	0	15	0	0	0	61
		Expected Count	16.8	9.9	5.7	9.6	4.5	3.9	5.7	4.8	61.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	315.759[a]	14	.000
Likelihood Ratio	391.076	14	.000
Linear-by-Linear Association	58.182	1	.000
N of Valid Cases	393		

3 cells (12.5%) have expected count less than 5. The minimum expected count is 3.88.

The above Table-31 exhibits statistically significant dependency (p-value =0.000) between the year of register and designation indicating the rejection of null hypothesis i.e. year of register and designation are associated.

H0 – year of register and designation are independent.

H1 – year of register and designation are dependent

The Designation and the year of register are significant. The faculty are register much more than expected in the 2003 and research scholar are registered more than expected in the years 2004,2006,2009 and 2011.

The research scholars are using relatively more than the expected over the years, while faculty is showing declined than the expected. This may be because of the researchers are more skilled, attitude, IQ levels. The researchers are capable of acquiring the apt skills whereas faculty is not able to coupe-up with the changes in the technology growth. This emphasizes, a tailor made customized relational interfaces are essential.

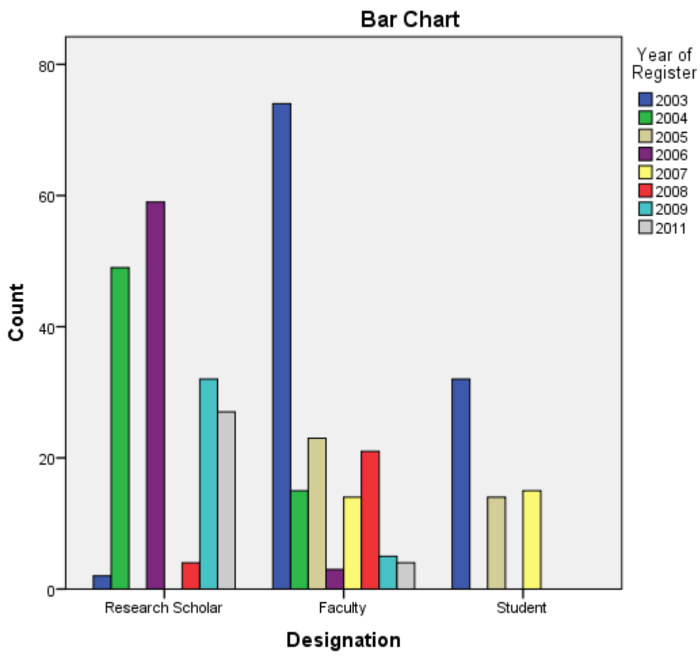


Figure 3 Designation vs Year of Register

Designation * Security of the Data

Table 30: Designation vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Designation	Research Scholar	Count	98	75	173
		Expected Count	96.4	76.6	173.0
	Faculty	Count	96	63	159
		Expected Count	88.6	70.4	159.0
	Student	Count	25	36	61
		Expected Count	34.0	27.0	61.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.827[a]	2	.033
Likelihood Ratio	6.796	2	.033
Linear-by-Linear Association	2.243	1	.134

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.01.

The above cross Table-32 exhibits statistically significant dependency (p-value =0.033) between the Security of the Data and designation.

H0 – Security of the Data and designation are independent.

H1 – Security of the Data and designation are dependent

From the above Table-32, the faculty rated the security of the data consistent and reliable, whereas the research scholar and students are rated excellent.

The Designation and the security of the data are significant. The faculty is using the security of the data more than expected.

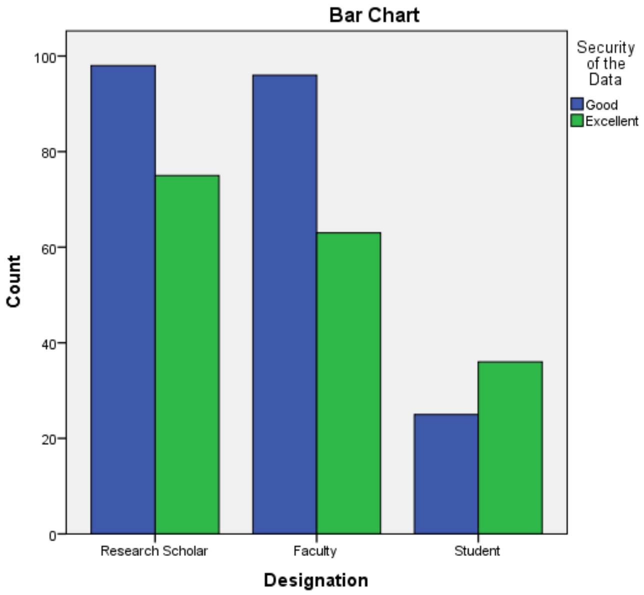


Figure 4 Designation vs Security of the Data

Designation * Supercomputing Resource-1

Table 31: Designation vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Designation	Research Scholar	Count	53	6	18	8	30	7	17	139
		Expected Count	30.4	17.1	15.6	9.7	36.6	9.3	20.2	139.0
	Faculty	Count	17	29	16	13	45	11	26	157
		Expected Count	34.3	19.4	17.6	11.0	41.3	10.6	22.9	157.0
	Student	Count	8	9	6	4	19	6	9	61
		Expected Count	13.3	7.5	6.8	4.3	16.1	4.1	8.9	61.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.863[a]	12	.000
Likelihood Ratio	46.898	12	.000
Linear-by-Linear Association	10.078	1	.002
N of Valid Cases	357		

a. 2 cells (9.5%) have expected count less than 5. The minimum expected count is 4.10.

The above cross Table-33 exhibits statistically significant dependency (p-value =0.000) between the Supercomputing Resource-1 and designation indicating the rejection of null hypothesis i.e. Supercomputing Resource-1 and designation are associated.

H0 – Supercomputing Resource-1 and designation are independent.

H1 – Supercomputing Resource-1 and designation are dependent.

The Designation and the supercomputing resource-1 are more significant.

From the above Table-33 research scholars are requesting for additional RAM and more time allocation for their jobs. The faculty is want of more disk space, reservation of resources and better network facility. The research scholars requires the more RAM and CPU time more than expected

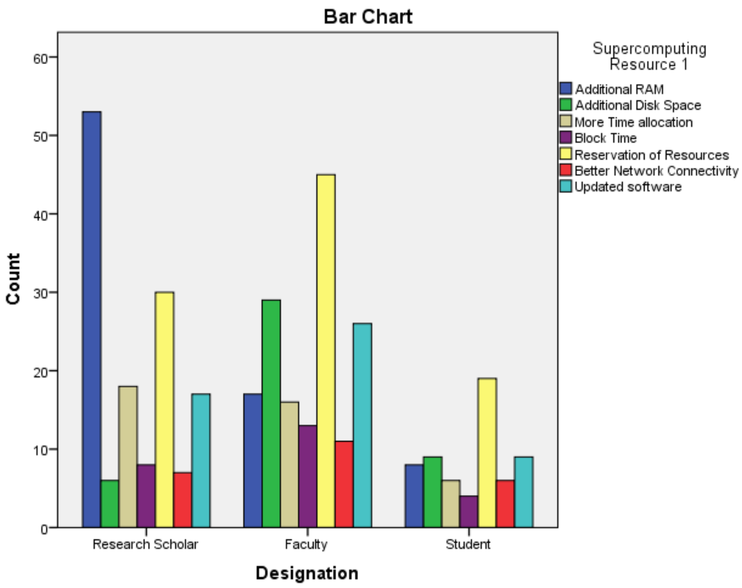


Figure 5 Designation vs Supercomputing Resource-1

Organization * Field of Research

Table 32: Organization vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
		Count	30	75	113	98	11	0	8	335

Organization	UNIVERSITY OF HYDERABAD	Expected Count	27.3	78.4	109.1	92.1	17.9	3.4	6.8	335.0
	Other	Count	2	17	15	10	10	4	0	58
		Expected Count	4.7	13.6	18.9	15.9	3.1	.6	1.2	58.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	48.903[a]	6	.000
Likelihood Ratio	37.728	6	.000
Linear-by-Linear Association	13.701	1	.000
N of Valid Cases	393		

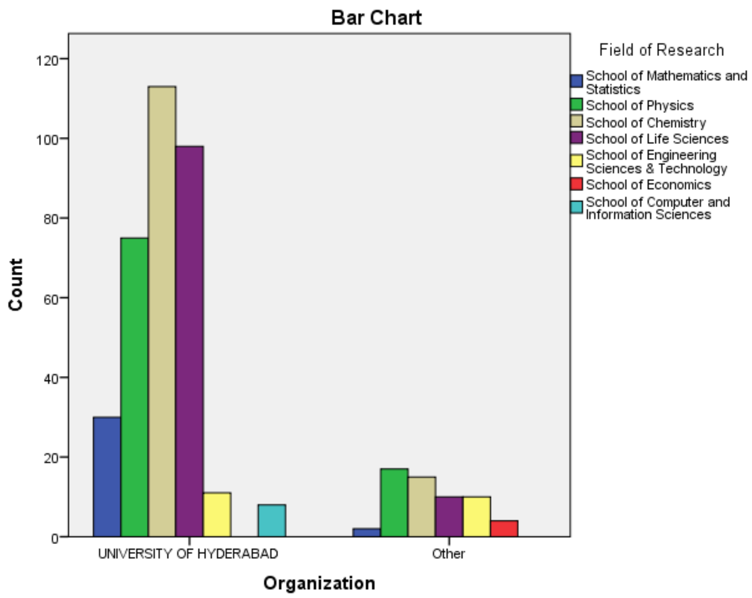


Figure 6 Organization vs Field of Research

The above cross Table-34 exhibits statistically significant dependency (p-value =0.000) between the Organization and Field of Research indicating the rejection of null hypothesis i.e. Organization and Field of Research are associated.

H0 – Organization and Field of Research are independent.

H1 – Organization and Field of Research are dependent

The Organization and Field of Research are more significant.

From the above Table-34 Research scholars of School of Life Sciences, School of Chemistry, School of Physics, are School of Mathematics and Statistics are using more University of Hyderabad High Performance Computing Facility.

Organization * Year of Register

Table 33: Organization vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Organization	UNIVERSITY OF HYDERABAD	Count	88	59	32	50	23	18	35	30	335
		Expected Count	92.1	54.6	31.5	52.8	24.7	21.3	31.5	26.4	335.0
	Other	Count	20	5	5	12	6	7	2	1	58
		Expected Count	15.9	9.4	5.5	9.2	4.3	3.7	5.5	4.6	58.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.901[a]	7	.037
Likelihood Ratio	16.498	7	.021
Linear-by-Linear Association	1.675	1	.196
N of Valid Cases	393		

a. 3 cells (18.8%) have expected count less than 5. The minimum expected count is 3.69.

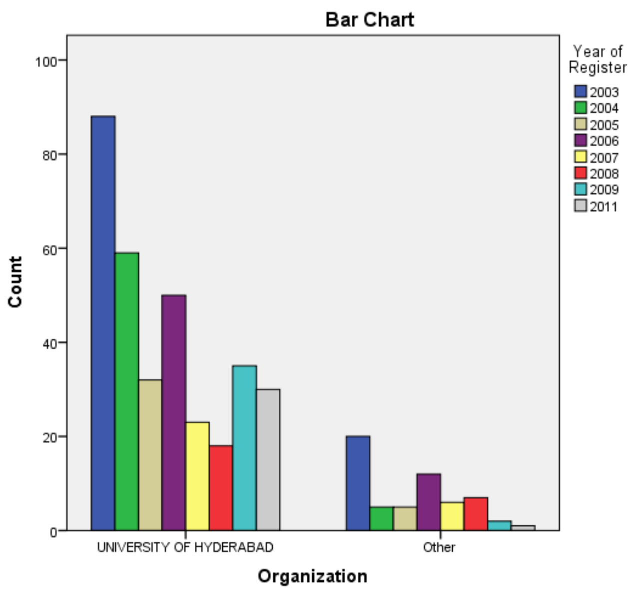


Figure 7 Organization vs Year of Register

The above cross Table-35 exhibits statistically significant dependency (p-value =0.037) between the Year of register and Organization.

H0 – Organization and Year of Register are independent.

H1 – Organization and Year of Register are dependent.

The Organization and Year of Register are significant.

From the above Table-35 outside users are using less in number. It needs to increase/develop the skills network connectivity support, virtual guidance to support remotely by email/online. The Organization and Year of Register are significant.

Organization * Frequency of Job Submission

Table 34: Organization vs Frequency of Job Submission

			Frequency of Job Submission		Total
			Daily	Weekly	
Organization	UNIVERSITY OF HYDERABAD	Count	156	179	335
		Expected Count	164.5	170.5	335.0
	Other	Count	37	21	58
		Expected Count	28.5	29.5	58.0
Total		Count	193	200	393
		Expected Count	193.0	200.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.870[a]	1	.015		
Continuity Correction[b]	5.201	1	.023		
Likelihood Ratio	5.927	1	.015		
Fisher's Exact Test				.016	.011
Linear-by-Linear Association	5.855	1	.016		

The above cross Table-36 exhibits statistically significant dependency (p-value =0.015) between the Organization and Frequency of job submission.

H0 – Organization and Frequency of job submission are independent.

H1 – Organization and Frequency of job submission are dependent

The Organization and Frequency of job submission are significant.

From the above Table-36 the Frequency of job submission is more by the weekly users of University of Hyderabad High Performance Computing Facility.

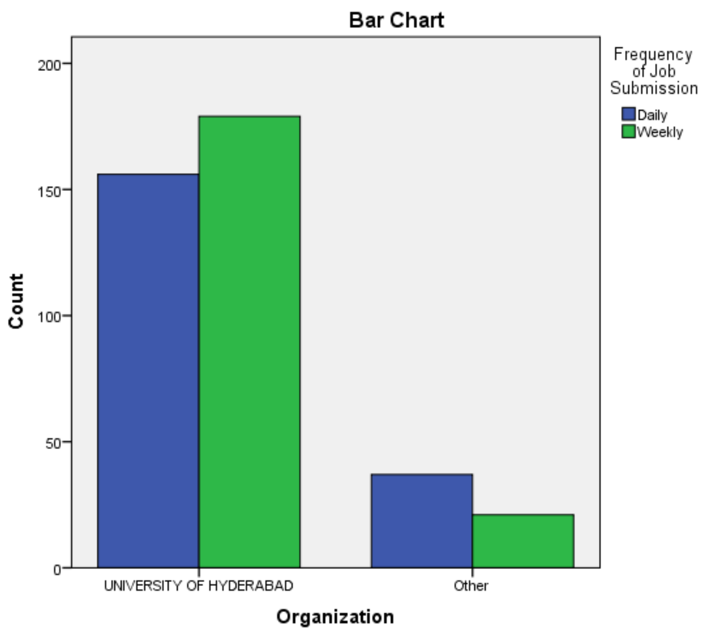


Figure 8 Organization vs Frequency of Job Submission

Organization * Use of HPC

Table 35: Organization vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Organization	UNIVERSITY OF HYDERABAD	Count	146	156	28	5	335
		Expected Count	156.0	148.3	25.6	5.1	335.0
	Other	Count	37	18	2	1	58
		Expected Count	27.0	25.7	4.4	.9	58.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.610[a]	3	.035
Likelihood Ratio	8.839	3	.032
Linear-by-Linear Association	6.321	1	.012
N of Valid Cases	393		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is .89.

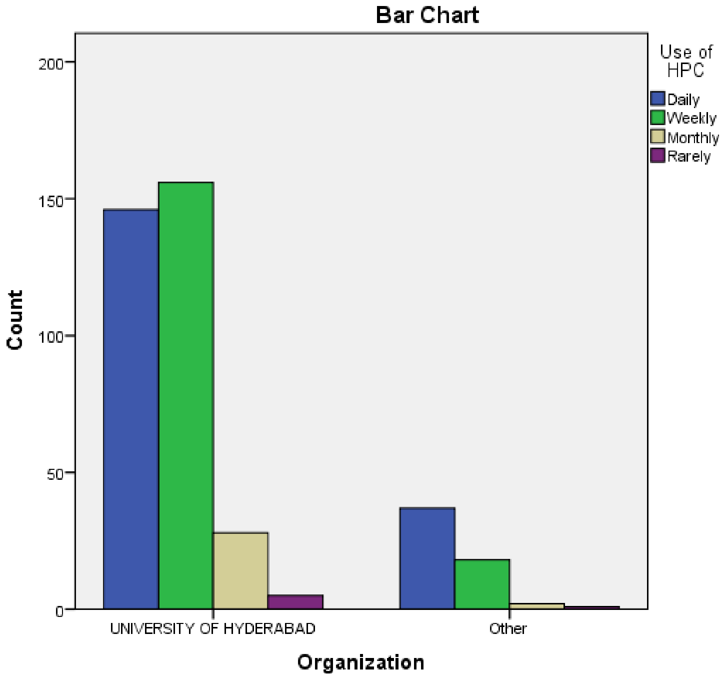


Figure 9 Organization vs Use of HPC

The above cross Table-37 exhibits statistically significant dependency (p-value =0.035) between the Organization and Use of HPC.

H0 – Organization and Use of HPC are independent.

H1 – Organization and Use of HPC are dependent

The Organization and Use of HPC are significant.

From the above Table-37 the Use of HPC is more than expected by the weekly users of University of Hyderabad High Performance Computing Facility.

Organization * Application Parallel or Serial

Table 36: Organization vs Application Parallel or Serial

			Application Parallel or Serial		Total
			Parallel	Serial	
Organization	UNIVERSITY OF HYDERABAD	Count	192	143	335
		Expected Count	199.5	135.5	335.0
	Other	Count	42	16	58
		Expected Count	34.5	23.5	58.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.680[a]	1	.031		
Continuity Correction[b]	4.074	1	.044		
Likelihood Ratio	4.873	1	.027		
Fisher's Exact Test				.031	.020
Linear-by-Linear Association	4.668	1	.031		
N of Valid Cases	393				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.47.
b. Computed only for a 2x2 table

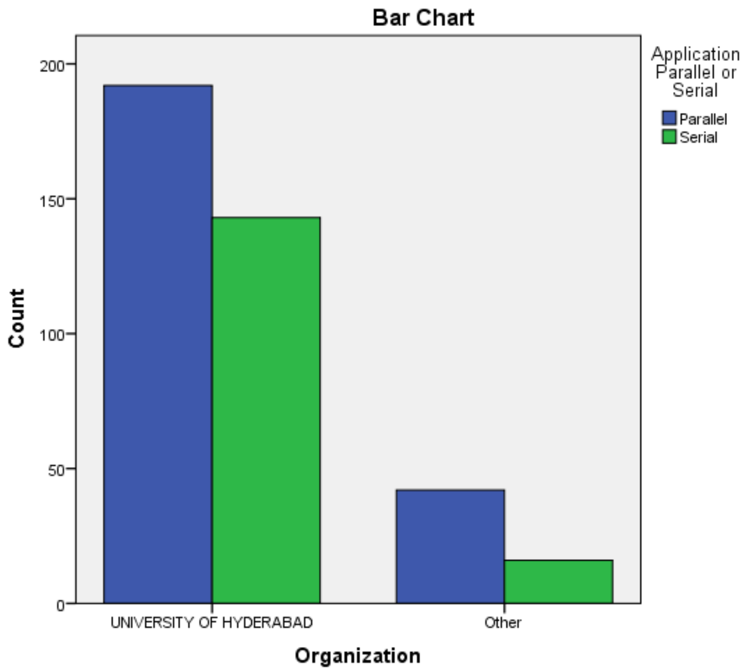


Figure 10 Organization vs Application Parallel or Serial

The above cross Table-38 exhibits statistically significant dependency (p-value =0.031) between the Organization and Application Parallel or Serial.

H0 – Organization and Application Parallel or Serial are independent.

H1 – Organization and Application Parallel or Serial are dependent

The Organization and Application Parallel or Serial are significant.

From the above Table-38 the Application Serial users are using more than expected the facility of University of Hyderabad High Performance Computing Facility.

University of Hyderabad users are using more serial jobs than the remote login users. The real utilization of the HPC is can be achieved by controlling the serial jobs. We can derive the objective of the HPC facility.

Organization * Supercomputing Resource-1

Table 37: Organization vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Organization	UNIVERSITY OF HYDERABAD	Count	73	38	35	23	72	16	46	303
		Expected Count	66.2	37.3	33.9	21.2	79.8	20.4	44.1	303.0
	Other	Count	5	6	5	2	22	8	6	54
		Expected Count	11.8	6.7	6.1	3.8	14.2	3.6	7.9	54.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.631[a]	6	.007
Likelihood Ratio	17.055	6	.009
Linear-by-Linear Association	5.632	1	.018
N of Valid Cases	357		

b. 2 cells (14.3%) have expected count less than 5. The minimum expected count is 3.63

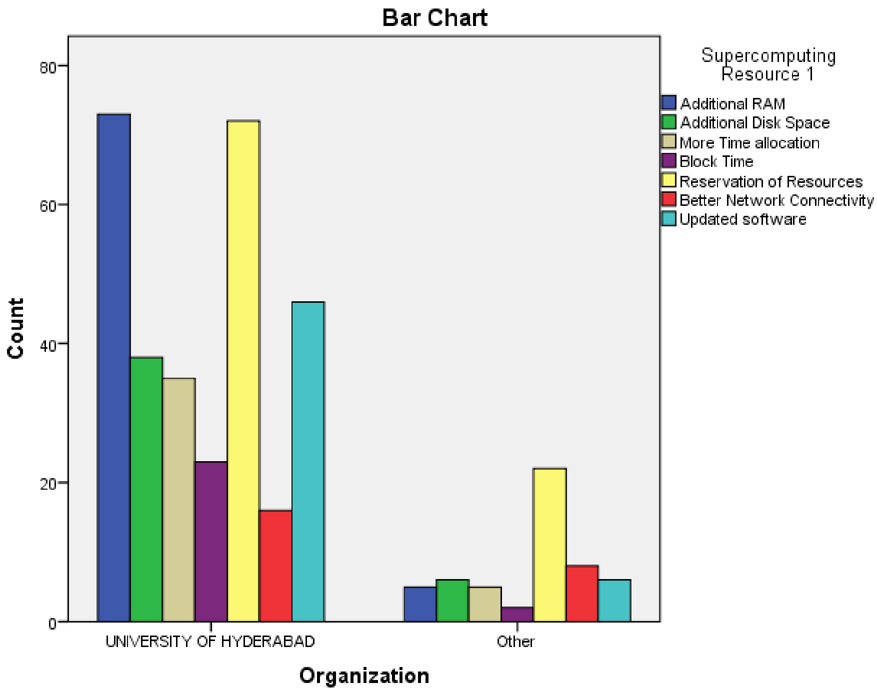


Figure 11 Organization vs Supercomputing Resource-1

The above cross Table-39 exhibits statistically significant dependency (p-value =0.007) between the Organization and Supercomputing Resource-1 and Organization.

H0 – Organization and Supercomputing Resource-1 are independent.

H1 – Organization and Supercomputing Resource-1 are dependent

The Organization and Supercomputing Resource-1 are significant.

From the above Table-39 the Users are requesting the more RAM, Disk space and updated software at University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Field of Research

Table 38: Frequency of Job Submission vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Frequency of Job Submission	Daily	Count	15	60	66	44	6	0	2	193
		Expected Count	15.7	45.2	62.9	53.0	10.3	2.0	3.9	193.0
	Weekly	Count	17	32	62	64	15	4	6	200
		Expected Count	16.3	46.8	65.1	55.0	10.7	2.0	4.1	200.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.215[a]	6	.001
Likelihood Ratio	24.132	6	.000
Linear-by-Linear Association	13.592	1	.000
N of Valid Cases	393		

a. 4 cells (28.6%) have expected count less than 5. The minimum expected count is 1.96.

The above cross Table-40 exhibits statistically significant dependency (p-value =0.001) between the Frequency of Job Submission and Field of Research.

H0 – Frequency of Job Submission and Field of Research are independent.

H1 – Frequency of Job Submission and Field of Research are dependent

The Frequency of Job Submission and Field of Research are significant.

From the above Table-40 the Frequency of Job Submission by the researchers of school of chemistry is high of daily while the faculty of life science is more for weekly job submission at University of Hyderabad High Performance Computing Facility.

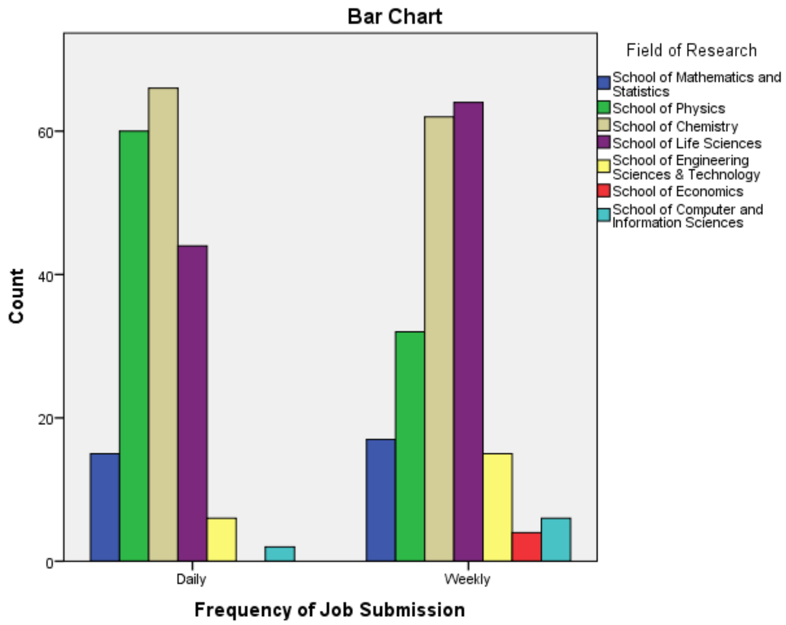


Figure 12 Frequency of Job Submission vs Field of Research

Frequency of Job Submission * Group of Software Packages Used-2

Table 39: Frequency of Job Submission vs Group of Software Packages Used-2

			Group of Software Packages Used-2				
			Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Economics Software	Total
Frequency of Job Submission	Daily	Count	110	41	27	0	178
		Expected Count	116.4	33.0	26.6	2.0	178.0
	Weekly	Count	126	26	27	4	183
		Expected Count	119.6	34.0	27.4	2.0	183.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.375[a]	3	.039
Likelihood Ratio	9.948	3	.019
Linear-by-Linear Association	.140	1	.708
N of Valid Cases	361		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.97.

The above cross Table-41 exhibits statistically significant dependency (p-value =0.039) between the Frequency of Job Submission and Group of Software Packages used-2.

The Frequency of Job Submission and Group of Software Packages used-2 are significant.

H0 – Frequency of Job Submission and Group of Software Packages used-2 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-2 are dependent

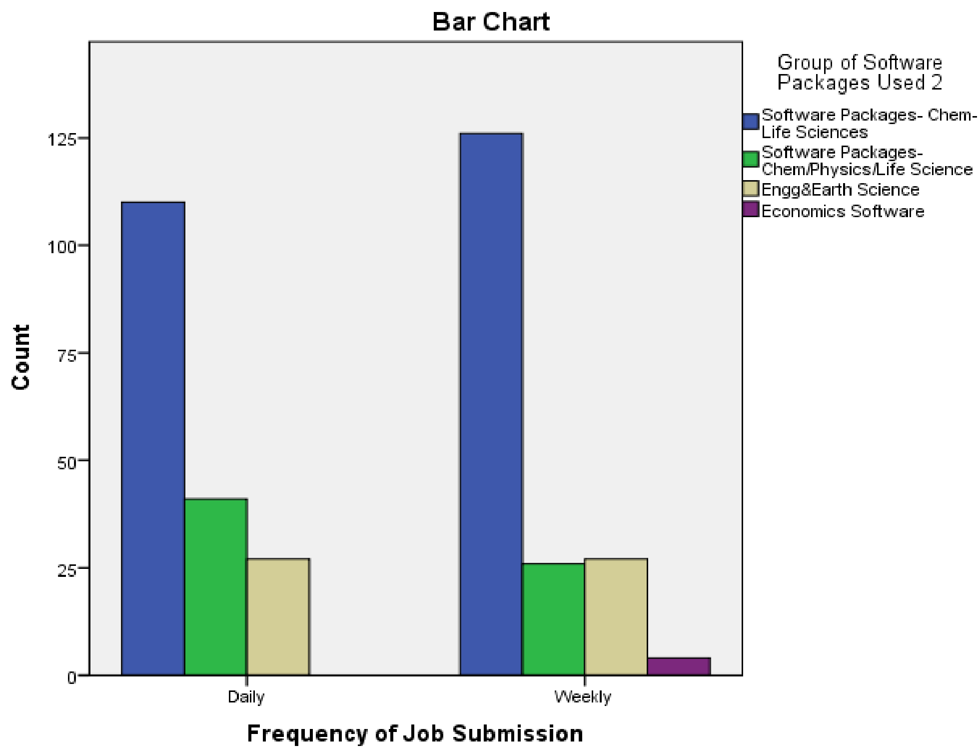


Figure 13 Frequency of Job Submission vs Group of Software Packages Used-2

Frequency of Job Submission * Group of Software Packages Used-3

Table 40: Frequency of Job Submission vs Group of Software Packages Used-3

			Group of Software Packages Used-3			Total
			Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Software Packages-Chem/Physics/Enng Science	
Frequency of Job Submission	Daily	Count	110	4	58	172
		Expected Count	120.8	5.1	46.1	172.0
	Weekly	Count	126	6	32	164
		Expected Count	115.2	4.9	43.9	164.0
Total		Count	236	10	90	336
		Expected Count	236.0	10.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.810[a]	2	.012
Likelihood Ratio	8.917	2	.012
Linear-by-Linear Association	8.174	1	.004
N of Valid Cases	336		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.88.

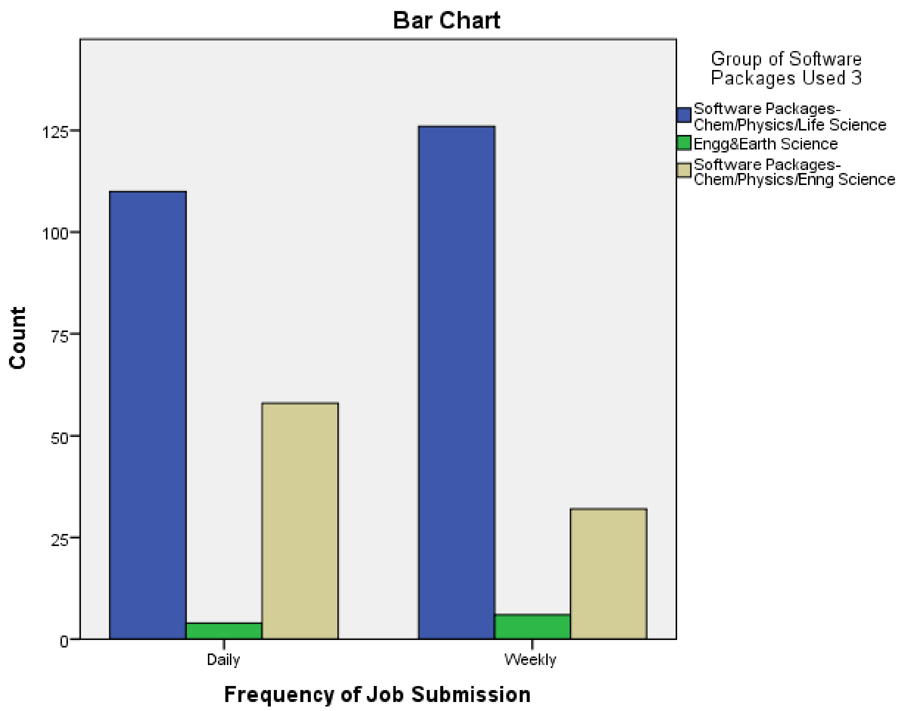


Figure 14 Frequency of Job Submission vs Group of Software Packages Used-3

The above cross Table-42 exhibits statistically significant dependency (p-value =0.012) between the Frequency of Job Submission and Group of Software Packages used-3.

H0 – Frequency of Job Submission and Group of Software Packages used-3 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-3 are dependent

The Frequency of Job Submission and Group of Software Packages used-3 are significant.

From the above Table-42 the Frequency of Job Submission by the faculty are using the using Group of Software Packages used-3 is more for weekly job submission at users University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Group of Software Packages Used-4

Table 41: Frequency of Job Submission vs Group of Software Packages Used-4

			Group of Software Packages Used-4				
			Economics Software	Software Packages- Chem/Physics/Enng Science	Software Packages - Life science	Software Packages -Physics Chemistry	Total
Frequency of Job Submission	Daily	Count	4	66	44	58	172
		Expected Count	5.1	65.5	55.3	46.1	172.0
	Weekly	Count	6	62	64	32	164
		Expected Count	4.9	62.5	52.7	43.9	164.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.556[a]	3	.009
Likelihood Ratio	11.682	3	.009
Linear-by-Linear Association	3.016	1	.082
N of Valid Cases	336		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.88.

The above cross Table-43 exhibits statistically significant dependency (p-value =0.009) between the Frequency of Job Submission and Group of Software Packages used-4.

H0 – Frequency of Job Submission and Group of Software Packages used-4 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-4 are dependent

The Frequency of Job Submission and Group of Software Packages used-4 are significant.

From the above Table-43 the Frequency of Job Submission by the faculty are using the using Group of Software Packages used-4 is more for weekly job submission at users University of Hyderabad High Performance Computing Facility.

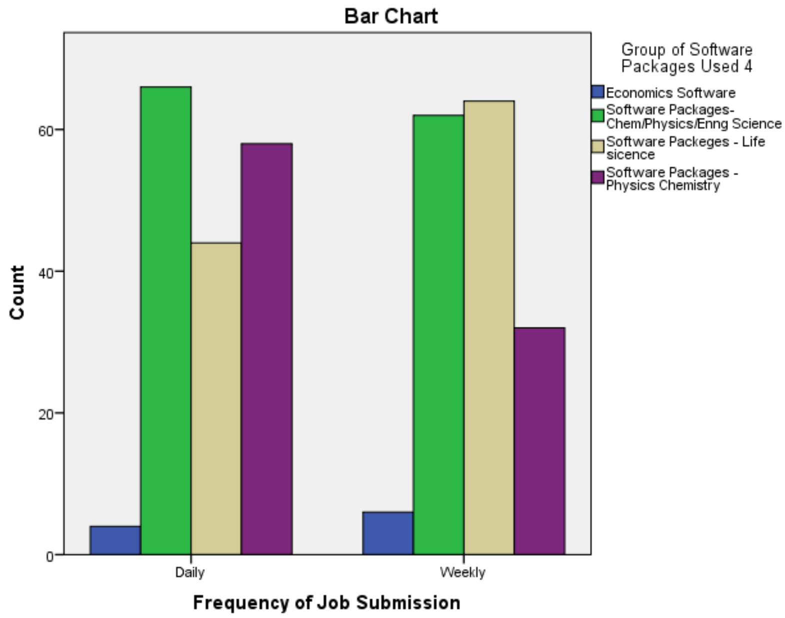


Figure 15 Frequency of Job Submission vs Group of Software Packages Used-4

Frequency of Job Submission * Year of Register

Table 42: Frequency of Job Submission vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Frequency of Job Submission	Daily	Count	37	41	23	33	20	15	16	8	193
		Expected Count	53.0	31.4	18.2	30.4	14.2	12.3	18.2	15.2	193.0
	Weekly	Count	71	23	14	29	9	10	21	23	200
		Expected Count	55.0	32.6	18.8	31.6	14.8	12.7	18.8	15.8	200.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)

Pearson Chi-Square	31.205[a]	7	.000
Likelihood Ratio	31.899	7	.000
Linear-by-Linear Association	.086	1	.769
N of Valid Cases	393		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.28.

The above Table-44 exhibits statistically significant dependency (p-value =0.000) between the Frequency of Job Submission and Year of Register.

H0 – Frequency of Job Submission and Year of Register are independent.

H1 – Frequency of Job Submission and Year of Register are dependent

The Frequency of Job Submission and Year of Register are significant.

The latent registered utility of the infrastructure of HPC is getting dropped than the excepted. Rapid awareness, effective utilization, training programmes through e-CRM among the recently registered users. Through which the latency in full utilization can be minimize.

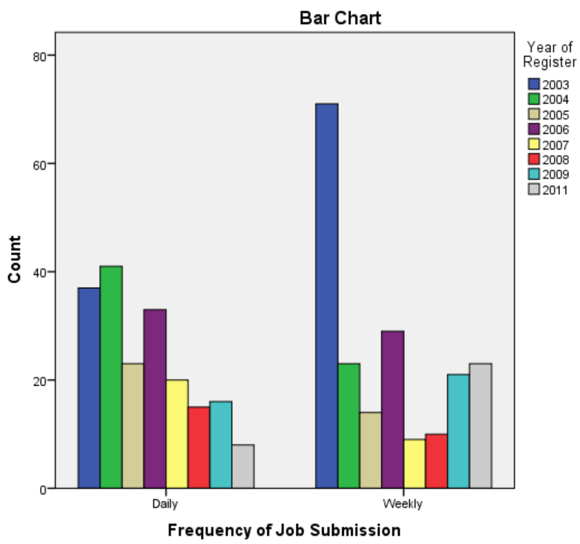


Figure 16 Frequency of Job Submission vs Group of Software Packages Used-4

Frequency of Job Submission * Use of HPC

Table 43: Frequency of Job Submission vs Use of HPC

	Use of HPC	Total

			Daily	Weekly	Monthly	Rarely	
Frequency of Job Submission	Daily	Count	154	22	11	6	193
		Expected Count	89.9	85.5	14.7	2.9	193.0
	Weekly	Count	29	152	19	0	200
		Expected Count	93.1	88.5	15.3	3.1	200.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	190.578[a]	3	.000
Likelihood Ratio	213.186	3	.000
Linear-by-Linear Association	81.653	1	.000
N of Valid Cases	393		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.95.

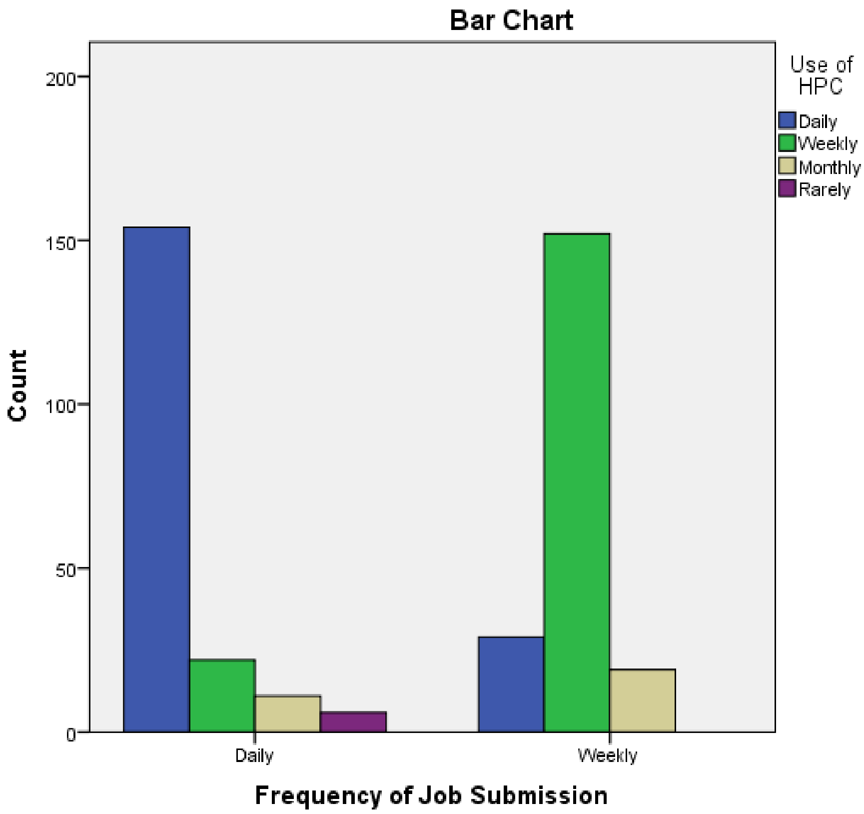


Figure 17 Frequency of Job Submission vs Use of HPC

The above cross Table-45 exhibits statistically significant dependency (p-value =0.000) between the Frequency of Job Submission and Use of HPC.

H0 – Frequency of Job Submission and Use of HPC are independent.

H1 – Frequency of Job Submission and Use of HPC are dependent

The Frequency of Job Submission and Use of HPC are significant.

From the above Table-45 the Researchers is more use of HPC daily and faculty using is using more on weekly at University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Job Submission Process

Table 44: Frequency of Job Submission vs Job Submission Process

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Frequency of Job Submission	Daily	Count	35	101	34	23	193
		Expected Count	45.7	95.8	33.9	17.7	193.0
	Weekly	Count	58	94	35	13	200
		Expected Count	47.3	99.2	35.1	18.3	200.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.610[a]	3	.035
Likelihood Ratio	8.703	3	.034
Linear-by-Linear Association	6.105	1	.013
N of Valid Cases	393		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.68.

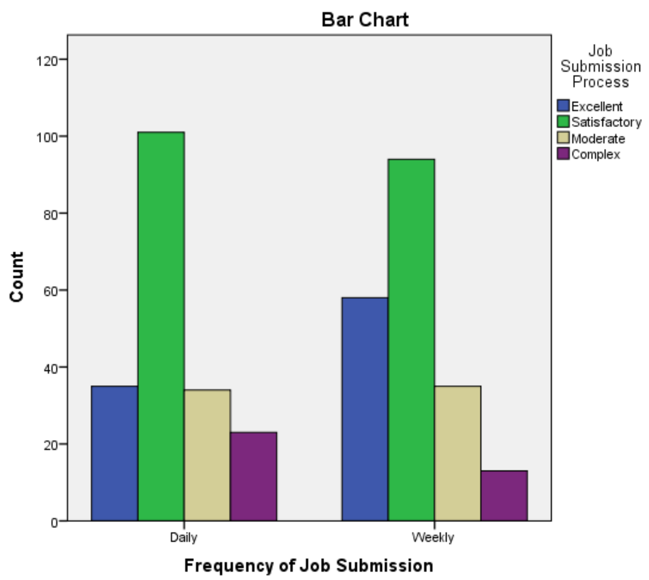


Figure 18 Frequency of Job Submission vs Job Submission Process

The above cross Table-46 exhibits statistically significant dependency (p-value =0.035) between the Frequency of Job Submission and Job submission process.

H0 – Frequency of Job Submission and Job submission process are independent.

H1 – Frequency of Job Submission and Job submission process are dependent.

The Frequency of Job Submission and Job submission process are significant.

The frequency of job submission is submitting the more complex than expected, henceforth the declining in the trend. The job submission process needs to be simplified.

Frequency of Job Submission * Application Parallel or Serial

Table 45: Frequency of Job Submission vs Application Parallel or Serial

			Application Parallel or Serial		
			Parallel	Serial	Total
Frequency of Job Submission	Daily	Count	101	92	193
		Expected Count	114.9	78.1	193.0
	Weekly	Count	133	67	200
		Expected Count	119.1	80.9	200.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.185[a]	1	.004		
Continuity Correction[b]	7.607	1	.006		
Likelihood Ratio	8.212	1	.004		
Fisher's Exact Test				.005	.003
Linear-by-Linear Association	8.164	1	.004		
N of Valid Cases	393				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 78.08.
b. Computed only for a 2x2 table

The above cross Table-47 exhibits statistically significant dependency (p-value =0.004) between the Frequency of Job Submission and Application Parallel or Serial.

H0 – Frequency of Job Submission and Application Parallel or Serial are independent.

H1 – Frequency of Job Submission and Application Parallel or Serial are dependent

The Frequency of Job Submission and Application Parallel or Serial is significant.

From the above Table-47 the Frequency of Job Submission is more by Parallel users in weekly and Serial by daily users at University of Hyderabad High Performance Computing Facility. The serial jobs needs to be reducing to meet the objective of the HPC.

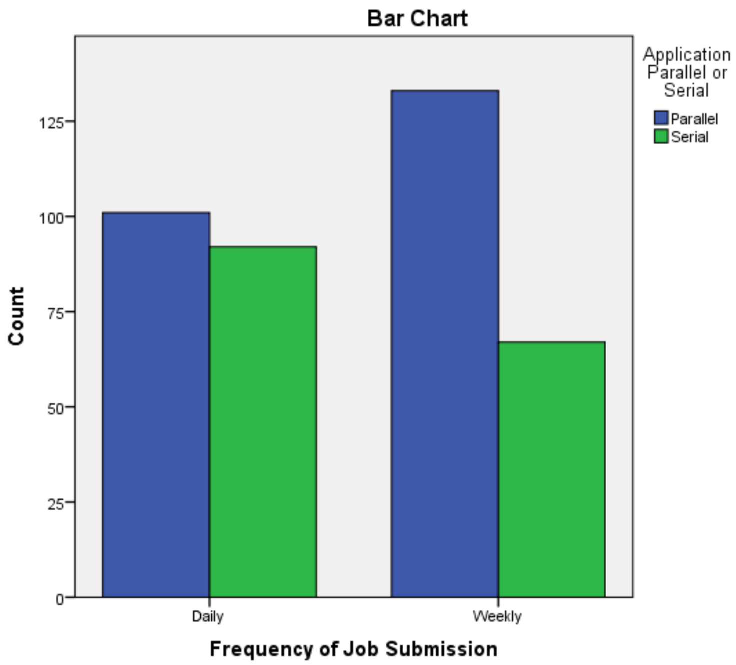


Figure 19 Frequency of Job Submission vs Application Parallel or Serial

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Use of HPC * Organization	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Field of Research	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Group of Software Packages Used 2	361	91.9%	32	8.1%	393	100.0%
Use of HPC * Group of Software Packages Used 3	336	85.5%	57	14.5%	393	100.0%
Use of HPC * Group of Software Packages Used 4	336	85.5%	57	14.5%	393	100.0%
Use of HPC * Year of Register	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Job Submission Process	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Nature of the Job	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Security of the Data	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Financial Support	393	100.0%	0	0.0%	393	100.0%
Use of HPC * HPC Rating	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Infrastructural Facility	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Supercomputing Resource 1	357	90.8%	36	9.2%	393	100.0%
Use of HPC * Supercomputing Resource 2	269	68.4%	124	31.6%	393	100.0%
Use of HPC * Supercomputing Resource 3	115	29.3%	278	70.7%	393	100.0%
Use of HPC * Supercomputing Resource 4	51	13.0%	342	87.0%	393	100.0%

Use of HPC * Field of Research

Table 46: Use of HPC vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Use of HPC	Daily	Count	17	60	57	41	6	0	2	183
		Expected Count	14.9	42.8	59.6	50.3	9.8	1.9	3.7	183.0
	Weekly	Count	12	21	57	61	13	4	6	174
		Expected Count	14.2	40.7	56.7	47.8	9.3	1.8	3.5	174.0
	Monthly	Count	3	7	12	6	2	0	0	30
		Expected Count	2.4	7.0	9.8	8.2	1.6	.3	.6	30.0
	Rarely	Count	0	4	2	0	0	0	0	6
		Expected Count	.5	1.4	2.0	1.6	.3	.1	.1	6.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.334[a]	18	.001
Likelihood Ratio	46.487	18	.000
Linear-by-Linear Association	4.099	1	.043
N of Valid Cases	393		

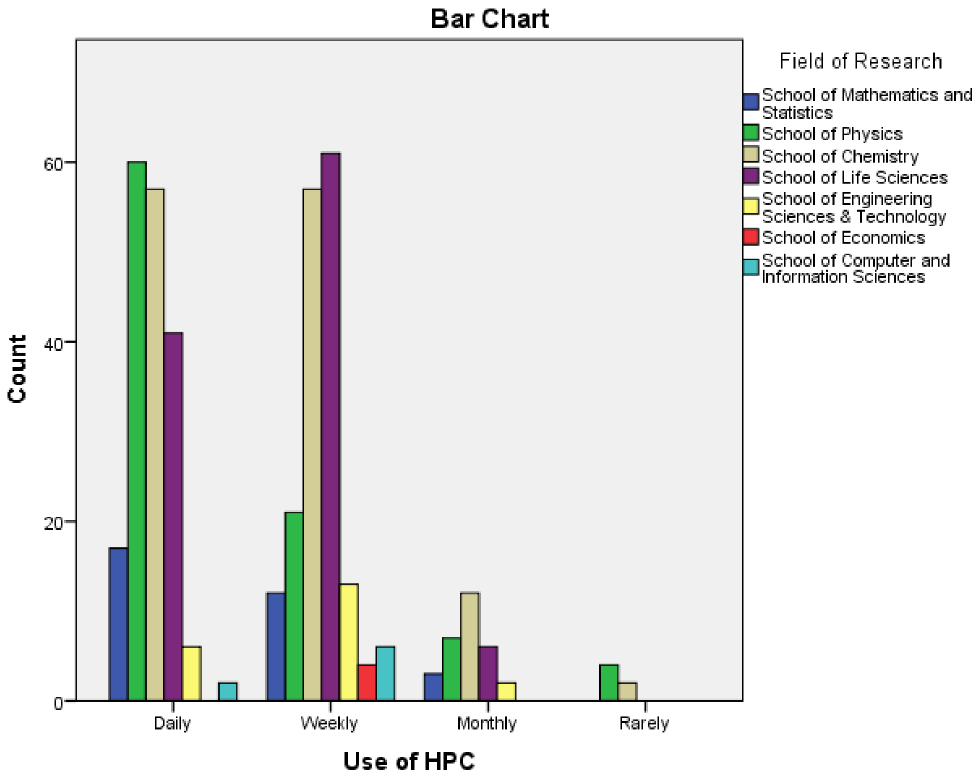


Figure 20 Use of HPC vs Field of Research

The above cross Table-48 exhibits statistically significant dependency (p-value =0.001) between the Use of HPC and Field of Research.

H0 – Use of HPC and Field of Research are independent.

H1 – Use of HPC and Field of Research are dependent

The Use of HPC and Field of Research are significant.

From the above Table-48 the School of physics is using HPC more in daily category at University of Hyderabad High Performance Computing Facility.

Use of HPC * Year of Register

Table 47: Use of HPC vs Year of Register

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	66.282[a]	21	.000
Likelihood Ratio	61.556	21	.000
Linear-by-Linear Association	7.804	1	.005
N of Valid Cases	393		

a. 15 cells (46.9%) have expected count less than 5. The minimum expected count is .38.

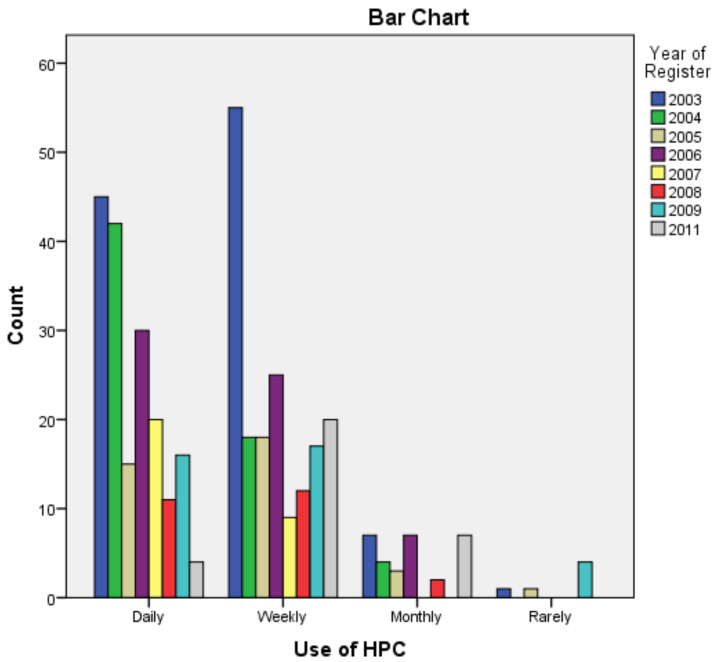


Figure 21 Use of HPC vs Year of Register

Use of HPC * Job Submission Process

Table 48: Use of HPC vs Year of Register

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Use of HPC	Daily	Count	40	87	40	16	183

		Expected Count	43.3	90.8	32.1	16.8	183.0
	Weekly	Count	37	96	23	18	174
		Expected Count	41.2	86.3	30.5	15.9	174.0
	Monthly	Count	16	6	6	2	30
		Expected Count	7.1	14.9	5.3	2.7	30.0
	Rarely	Count	0	6	0	0	6
		Expected Count	1.4	3.0	1.1	.5	6.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.873[a]	9	.001
Likelihood Ratio	29.824	9	.000
Linear-by-Linear Association	3.025	1	.082
N of Valid Cases	393		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .55.

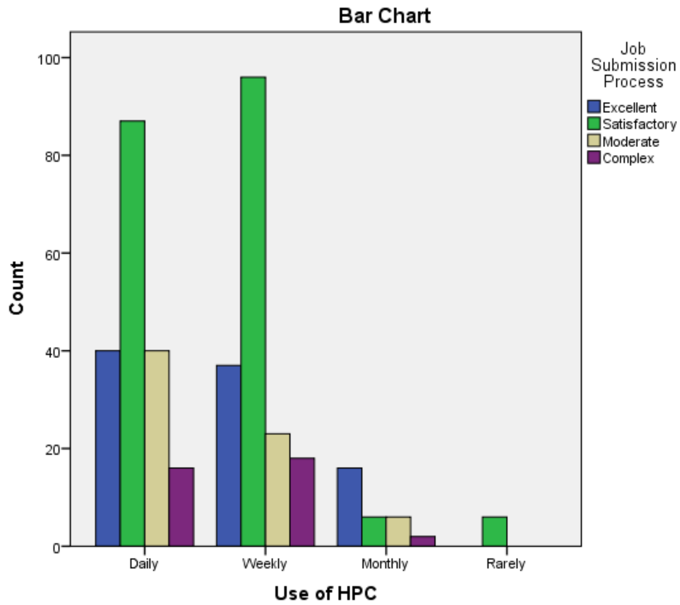


Figure 22 Use of HPC vs Year of Register

The above cross Table-50 exhibits statistically significant dependency (p-value =0.001) between the Use of HPC and Job submission Process.

H0 – Use of HPC and Job submission Process are independent.

H1 – Use of HPC and Job submission Process are dependent

The Use of HPC and Job submission Process are significant.

The daily users are well appreciated the job submission process, whereas others are expressed less satisfactory. Which indicates job submission process are highly technical need persistent efforts. A frame work embedded in e-CRM by simplifying in job submission process will enhance satisfaction levels.

Use of HPC * Nature of the Job

Table 49: Use of HPC vs Nature of the Job

			Nature of the Job			
			Parallelizable	Serial	Both	Total
Use of HPC	Daily	Count	77	5	101	183
		Expected Count	73.6	6.1	103.4	183.0
	Weekly	Count	79	4	91	174
		Expected Count	70.0	5.8	98.3	174.0
	Monthly	Count	2	0	28	30
		Expected Count	12.1	1.0	16.9	30.0
	Rarely	Count	0	4	2	6
		Expected Count	2.4	.2	3.4	6.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	95.034[a]	6	.000
Likelihood Ratio	45.534	6	.000
Linear-by-Linear Association	4.773	1	.029
N of Valid Cases	393		

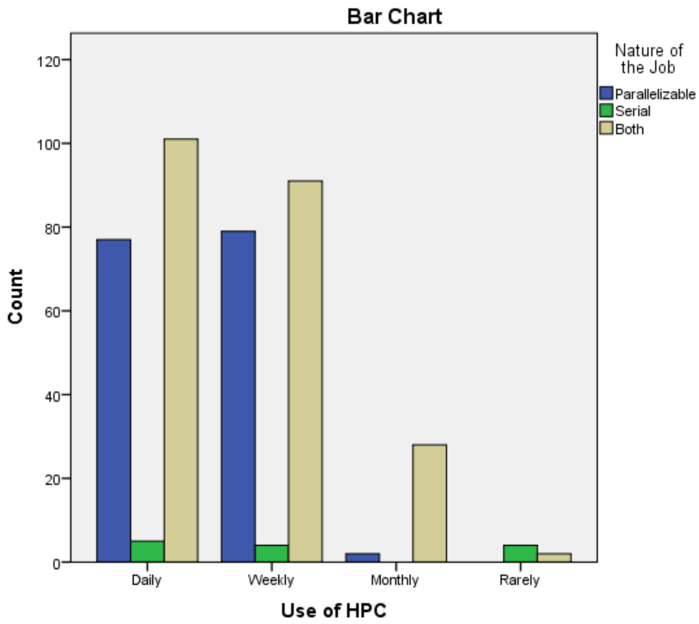


Figure 23 Use of HPC vs Nature of the Job

The above cross Table-51 exhibits statistically significant dependency (p-value =0.000) between the Use of HPC and Nature of the job.

H0 – Use of HPC and Nature of the job are independent.

H1 – Use of HPC and Nature of the job are dependent.

The Use of HPC and Nature of the job are significant.

The jobs which are expected to run long period like more than month usage of HPC is typically mixed category statistically significant more. An appropriate middleware management technology for customer to this to enhance the performance of the system.

Use of HPC * Security of the Data

Table 50: Use of HPC vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Use of HPC	Daily	Count	106	77	183
		Expected Count	102.0	81.0	183.0
	Weekly	Count	87	87	174
		Expected Count	97.0	77.0	174.0
	Monthly	Count	20	10	30
		Expected Count	16.7	13.3	30.0
	Rarely	Count	6	0	6
		Expected Count	3.3	2.7	6.0

Total	Count	219	174	393
	Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.893[a]	3	.031
Likelihood Ratio	11.167	3	.011
Linear-by-Linear Association	.453	1	.501
N of Valid Cases	393		

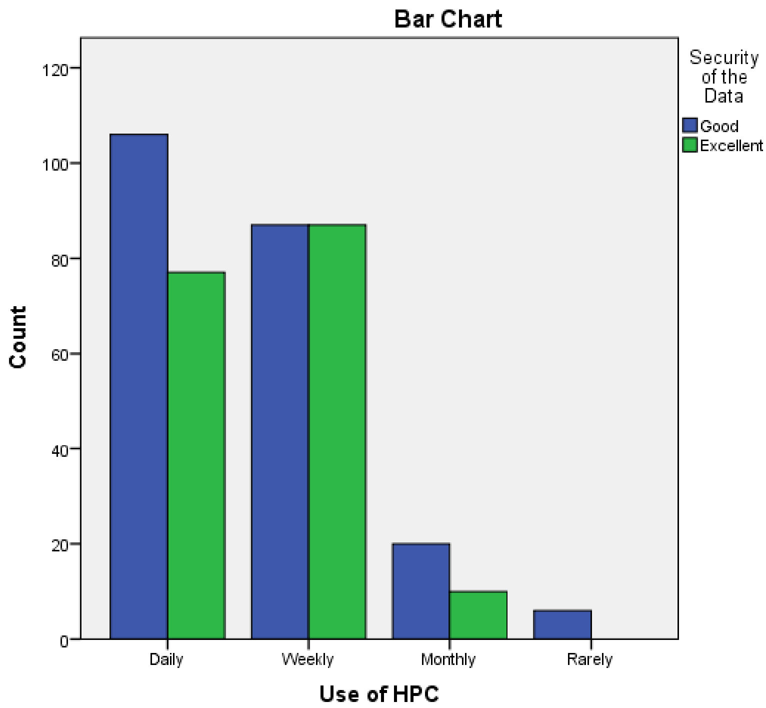


Figure 24 Use of HPC vs Security of the Data

The above Table-52 exhibits statistically significant dependency (p-value =0.031) between the Use of HPC and security of the Data.

H0 – Use of HPC and security of the Data are independent.

H1 – Use of HPC and security of the Data are dependent

The Use of HPC and security of the Data are significant.

The frequency of 'use of HPC' having relation with security of the Data. Frequent users expecting for better security of the Data than expected.

Use of HPC * Supercomputing Resource-1

Table 51: Use of HPC vs Supercomputing Resource-1

			Supercomputing Resource-1							Total
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	
Use of HPC	Daily	Count	29	20	24	15	44	10	21	163
		Expected Count	35.6	20.1	18.3	11.4	42.9	11.0	23.7	163.0
	Weekly	Count	39	23	13	6	42	14	23	160
		Expected Count	35.0	19.7	17.9	11.2	42.1	10.8	23.3	160.0
	Monthly	Count	9	1	3	2	7	0	8	30
		Expected Count	6.6	3.7	3.4	2.1	7.9	2.0	4.4	30.0
	Rarely	Count	1	0	0	2	1	0	0	4
		Expected Count	.9	.5	.4	.3	1.1	.3	.6	4.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.784[a]	18	.030
Likelihood Ratio	28.921	18	.049
Linear-by-Linear Association	.016	1	.899
N of Valid Cases	357		

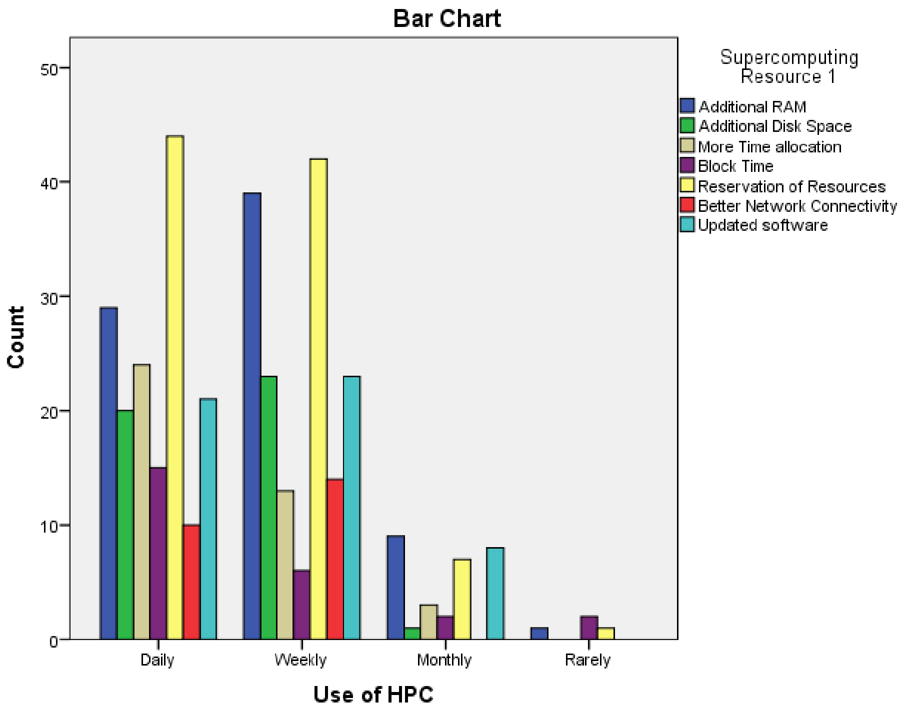


Figure 25 Use of HPC vs Supercomputing Resource-1

The above cross Table-53 exhibits statistically significant dependency (p-value =0.030) between the Use of HPC and Supercomputing Resource-1.

H0 – Use of HPC and Supercomputing Resource-1 are independent.

H1 – Use of HPC and Supercomputing Resource-1 are dependent

The Use of HPC and Supercomputing Resource-1 are significant.

From the above Table-56 the weekly users want additional RAM and daily user's wants to reservation of resources at University of Hyderabad High Performance Computing Facility.

Use of HPC * Supercomputing Resource-2

Table 52: Use of HPC vs Supercomputing Resource-2

			Supercomputing Resource - 2							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Use of HPC	Daily	Count	33	19	19	43	10	10	0	134
		Expected Count	34.4	17.4	13.4	40.3	11.0	14.9	2.5	134.0
	Weekly	Count	35	13	6	26	12	18	5	115
		Expected Count	29.5	15.0	11.5	34.6	9.4	12.8	2.1	115.0
	Monthly	Count	1	3	2	11	0	2	0	19

		Expected Count	4.9	2.5	1.9	5.7	1.6	2.1	.4	19.0
	Rarely	Count	0	0	0	1	0	0	0	1
		Expected Count	.3	.1	.1	.3	.1	.1	.0	1.0
Total		Count	69	35	27	81	22	30	5	269
		Expected Count	69.0	35.0	27.0	81.0	22.0	30.0	5.0	269.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.904[a]	18	.023
Likelihood Ratio	36.156	18	.007
Linear-by-Linear Association	3.080	1	.079
N of Valid Cases	269		

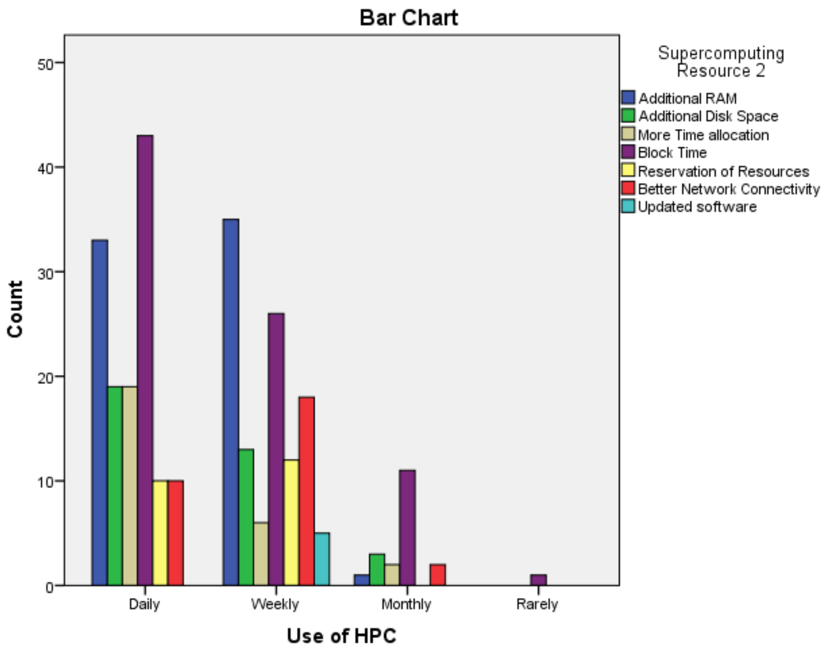


Figure 26 Use of HPC vs Supercomputing Resource-2

The above cross Table-54 exhibits statistically significant dependency (p-value =0.023) between the Use of HPC and Supercomputing Resource-2.

H0 – Use of HPC and Supercomputing Resource-2 are independent.

H1 – Use of HPC and Supercomputing Resource-2 are dependent

The Use of HPC and Supercomputing Resource-2 are significant.

Use of HPC * Supercomputing Resource-3

Table 53: Use of HPC vs Supercomputing Resource-3

			Supercomputing Resource -3					
			Additional RAM	Additional Disk Space	More Time allocation	Reservation of Resources	Updated software	Total
Use of HPC	Daily	Count	23	1	15	10	5	54
		Expected Count	23.5	2.3	14.1	11.7	2.3	54.0
	Weekly	Count	24	0	9	13	0	46
		Expected Count	20.0	2.0	12.0	10.0	2.0	46.0
	Monthly	Count	3	4	5	2	0	14
		Expected Count	6.1	.6	3.7	3.0	.6	14.0
	Rarely	Count	0	0	1	0	0	1
		Expected Count	.4	.0	.3	.2	.0	1.0
Total		Count	50	5	30	25	5	115
		Expected Count	50.0	5.0	30.0	25.0	5.0	115.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.303[a]	12	.000
Likelihood Ratio	28.943	12	.004
Linear-by-Linear Association	.572	1	.450
N of Valid Cases	115		

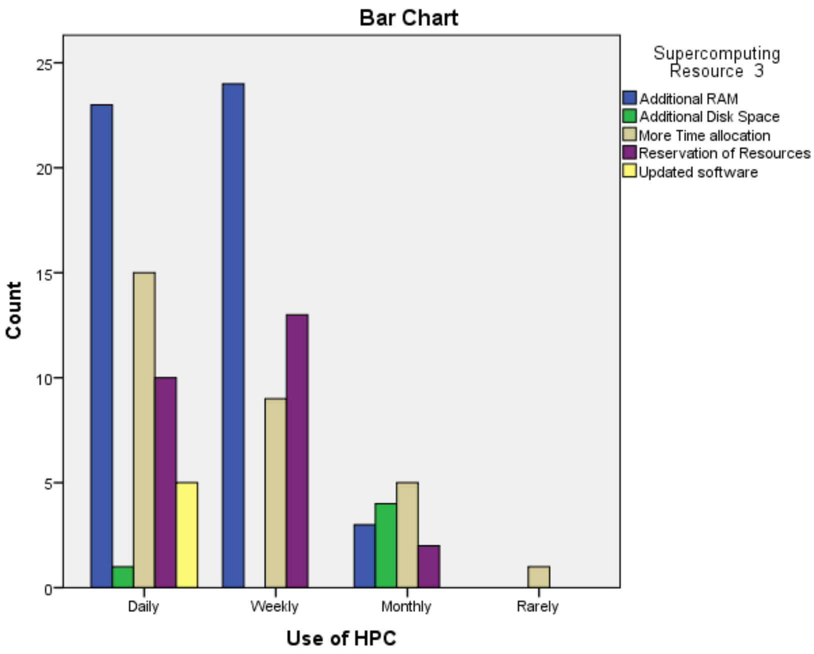


Figure 27 Use of HPC vs Supercomputing Resource-3

The above cross Table-55 exhibits statistically significant dependency (p-value =0.000) between the Use of HPC and Supercomputing Resource-3.

H0 – Use of HPC and Supercomputing Resource-3 are independent.

H1 – Use of HPC and Supercomputing Resource-3 are dependent

The Use of HPC and Supercomputing Resource-3 are significant.

From the above Table-55 the Users are requesting the more RAM, Disk space and updated software at University of Hyderabad High Performance Computing Facility.

Job Submission Process * Designation

Table 54: Job Submission Process vs Designation

			Designation			
			Research Scholar	Faculty	Student	Total
Job Submission Process	Excellent	Count	38	42	13	93
		Expected Count	40.9	37.6	14.4	93.0
	Satisfactory	Count	89	74	32	195
		Expected Count	85.8	78.9	30.3	195.0
	Moderate	Count	34	31	4	69
		Expected Count	30.4	27.9	10.7	69.0

	Complex	Count	12	12	12	36
		Expected Count	15.8	14.6	5.6	36.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.103[a]	6	.019
Likelihood Ratio	14.683	6	.023
Linear-by-Linear Association	.487	1	.485
N of Valid Cases	393		

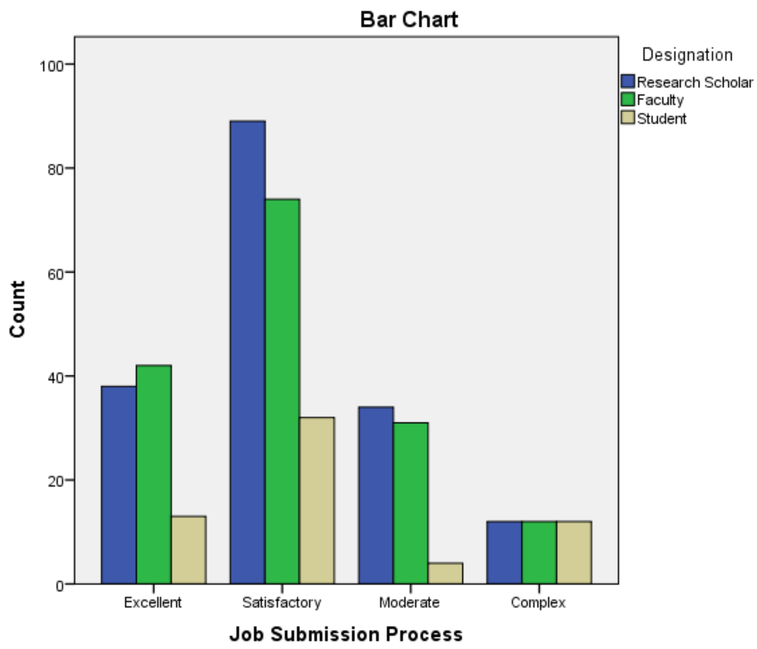


Figure 28 Job Submission Process vs Designation

The above cross Table-56 exhibits statistically significant dependency (p-value =0.019) between the Job Submission Process and Designation.

H0 – Job Submission Process and Designation are independent.

H1 – Job Submission Process and Designation are dependent

The Job Submission Process and Designation are significant.

The Research scholars expressing the Job Submission Process should be made more user-friendly. Hence, this leads to the Job Submission Process level satisfaction to level of excellent.

Job Submission Process * Field of Research

Table 55: Job Submission Process vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Job Submission Process	Excellent	Count	10	19	39	15	2	4	4	93
		Expected Count	7.6	21.8	30.3	25.6	5.0	.9	1.9	93.0
	Satisfactory	Count	17	47	62	56	13	0	0	195
		Expected Count	15.9	45.6	63.5	53.6	10.4	2.0	4.0	195.0
	Moderate	Count	2	16	21	22	4	0	4	69
		Expected Count	5.6	16.2	22.5	19.0	3.7	.7	1.4	69.0
	Complex	Count	3	10	6	15	2	0	0	36
		Expected Count	2.9	8.4	11.7	9.9	1.9	.4	.7	36.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

The above cross Table-57 exhibits statistically significant dependency (p-value =0.001) between the Job Submission Process and Field of Research.

H0 – Job Submission Process and Field of Research are independent.

H1 – Job Submission Process and Field of Research are dependent

The Job Submission Process and Field of Research are significant.

Job Submission Process * Group of Software Packages Used-4

Table 56: Job Submission Process vs Group of Software Packages Used-4

	Group of Software Packages Used-4	Total

			Economics Software	Software Packages-Chem/Physics/Enng Science	Software Packages - Life science	Software Packages - Physics Chemistry	
Job Submission Process	Excellent	Count	4	39	15	19	77
		Expected Count	2.3	29.3	24.8	20.6	77.0
	Satisfactory	Count	2	62	56	45	165
		Expected Count	4.9	62.9	53.0	44.2	165.0
	Moderate	Count	4	21	22	16	63
		Expected Count	1.9	24.0	20.3	16.9	63.0
	Complex	Count	0	6	15	10	31
		Expected Count	.9	11.8	10.0	8.3	31.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.997[a]	9	.018
Likelihood Ratio	21.209	9	.012
Linear-by-Linear Association	5.142	1	.023
N of Valid Cases	336		

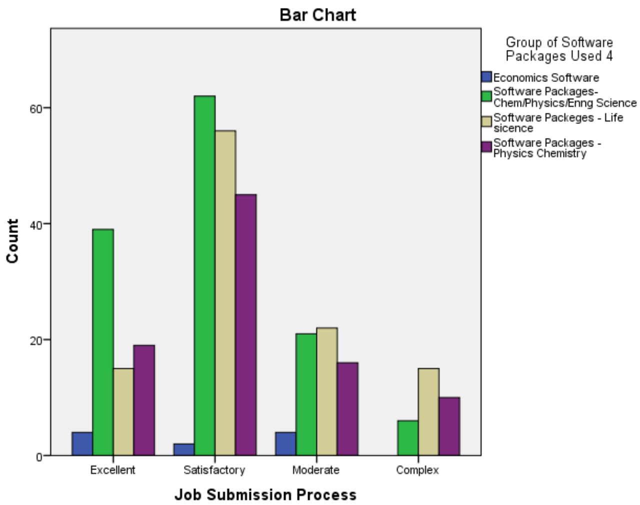


Figure 29 Job Submission Process vs Group of Software Packages Used-4

The above cross Table-58 exhibits statistically significant dependency (p-value =0.018) between the Group of Software Packages used4 and Job Submission Process.

H0 – Group of Software Packages used4 and Job Submission Process are independent.

H1 – Group of Software Packages used4 and Job Submission Process are dependent

The Group of Software Packages used4 and Job Submission Process are significant.

Job Submission Process * Year of Register

Table 57: Job Submission Process vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Job Submission Process	Excellent	Count	29	9	8	11	3	11	7	15	93
		Expected Count	25.6	15.1	8.8	14.7	6.9	5.9	8.8	7.3	93.0
	Satisfactory	Count	53	35	18	26	16	9	23	15	195
		Expected Count	53.6	31.8	18.4	30.8	14.4	12.4	18.4	15.4	195.0
	Moderate	Count	16	9	6	22	4	4	7	1	69
		Expected Count	19.0	11.2	6.5	10.9	5.1	4.4	6.5	5.4	69.0
	Complex	Count	10	11	5	3	6	1	0	0	36
		Expected Count	9.9	5.9	3.4	5.7	2.7	2.3	3.4	2.8	36.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	56.148[a]	21	.000
Likelihood Ratio	58.399	21	.000
Linear-by-Linear Association	7.991	1	.005
N of Valid Cases	393		

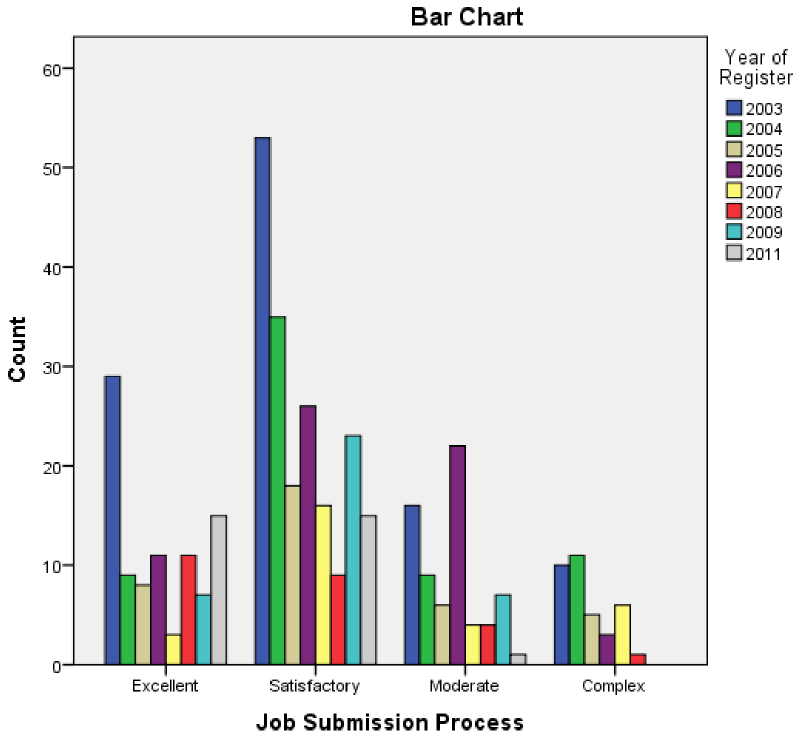


Figure 30 Job Submission Process vs Year of Register

The above cross Table-59 exhibits statistically significant dependency (p-value =0.000) between the Job Submission Process and Year of Register.

H0 – Job Submission Process and Year of Register are independent.

H1 – Job Submission Process and Year of Register are dependent

The Job Submission Process and Year of Register are significant.

Job Submission Process * Use of HPC

Table 58: Job Submission Process vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Job Submission Process	Excellent	Count	40	37	16	0	93
		Expected Count	43.3	41.2	7.1	1.4	93.0
	Satisfactory	Count	87	96	6	6	195
		Expected Count	90.8	86.3	14.9	3.0	195.0
	Moderate	Count	40	23	6	0	69

		Expected Count	32.1	30.5	5.3	1.1	69.0
	Complex	Count	16	18	2	0	36
		Expected Count	16.8	15.9	2.7	.5	36.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.873[a]	9	.001
Likelihood Ratio	29.824	9	.000
Linear-by-Linear Association	3.025	1	.082
N of Valid Cases	393		

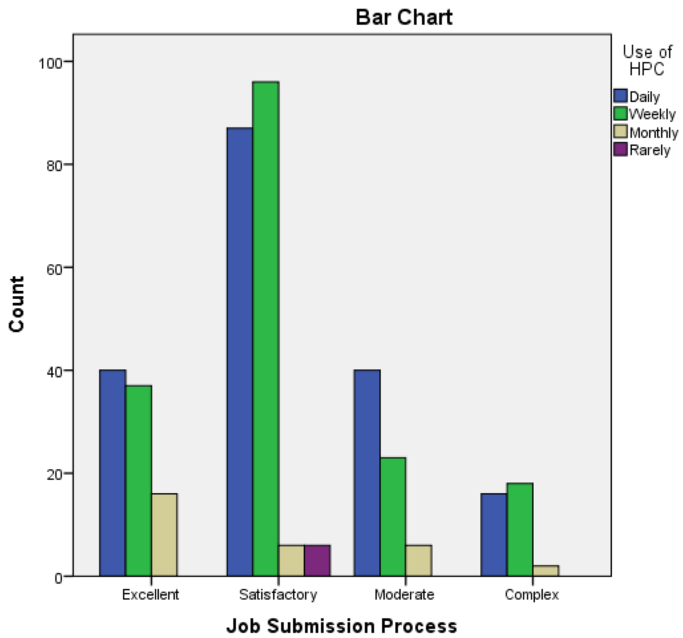


Figure 31 Job Submission Process vs Use of HPC

The above cross Table-60 exhibits statistically significant dependency (p-value =0.001) between the Job Submission Process and Use of HPC.

H0 – Job Submission Process and Use of HPC are independent.

H1 – Job Submission Process and Use of HPC are dependent

The Job Submission Process and Use of HPC are significant.

Job Submission Process * Financial Support

Table 59: Job Submission Process vs Financial Support

			Financial Support		
			Funding Agency	University - HPC	Total
Job Submission Process	Excellent	Count	30	63	93
		Expected Count	29.8	63.2	93.0
	Satisfactory	Count	73	122	195
		Expected Count	62.5	132.5	195.0
	Moderate	Count	17	52	69
		Expected Count	22.1	46.9	69.0
	Complex	Count	6	30	36
		Expected Count	11.5	24.5	36.0
Total		Count	126	267	393
		Expected Count	126.0	267.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.250[a]	3	.041
Likelihood Ratio	8.754	3	.033
Linear-by-Linear Association	4.098	1	.043
N of Valid Cases	393		

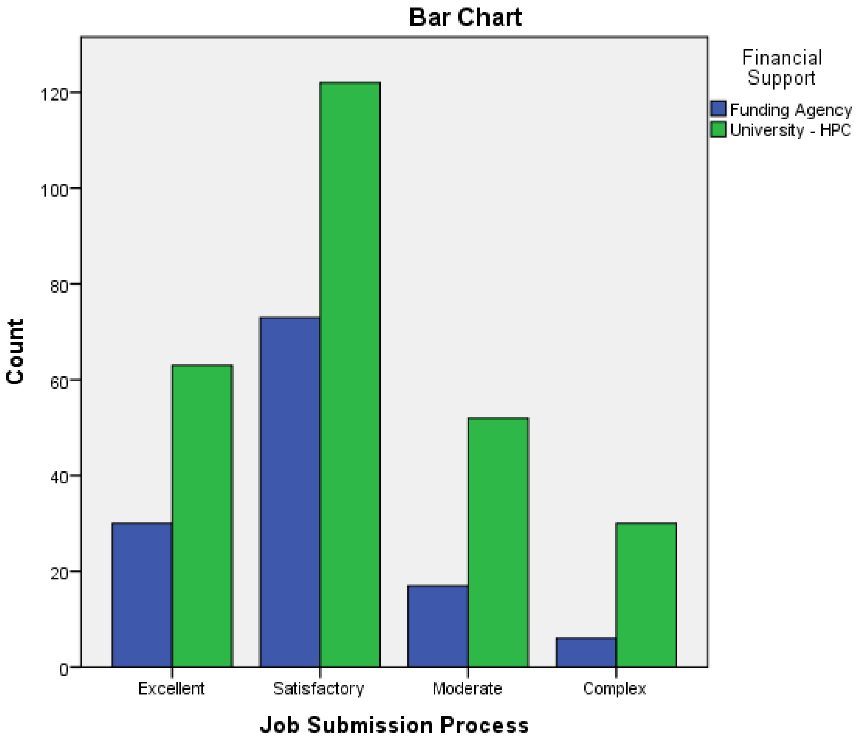


Figure 32 Job Submission Process vs Financial Support

The above cross Table-61 exhibits statistically significant dependency (p-value =0.041) between the Job Submission Process and Financial Support.

H0 – Job Submission Process and Financial Support are independent.

H1 – Job Submission Process and Financial Support are dependent

The Job Submission Process and Financial Support are significant.

Job Submission Process * Supercomputing Resource-1

Table 60: Job Submission Process vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Job Submission Process	Excellent	Count	23	11	10	10	26	5	8	93
		Expected Count	20.3	11.5	10.4	6.5	24.5	6.3	13.5	93.0
	Satisfactory	Count	42	26	18	10	31	15	25	167

		Expected Count	36.5	20.6	18.7	11.7	44.0	11.2	24.3	167.0
	Moderate	Count	11	6	5	3	21	2	17	65
		Expected Count	14.2	8.0	7.3	4.6	17.1	4.4	9.5	65.0
	Complex	Count	2	1	7	2	16	2	2	32
		Expected Count	7.0	3.9	3.6	2.2	8.4	2.2	4.7	32.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.525[a]	18	.002
Likelihood Ratio	40.855	18	.002
Linear-by-Linear Association	7.342	1	.007
N of Valid Cases	357		

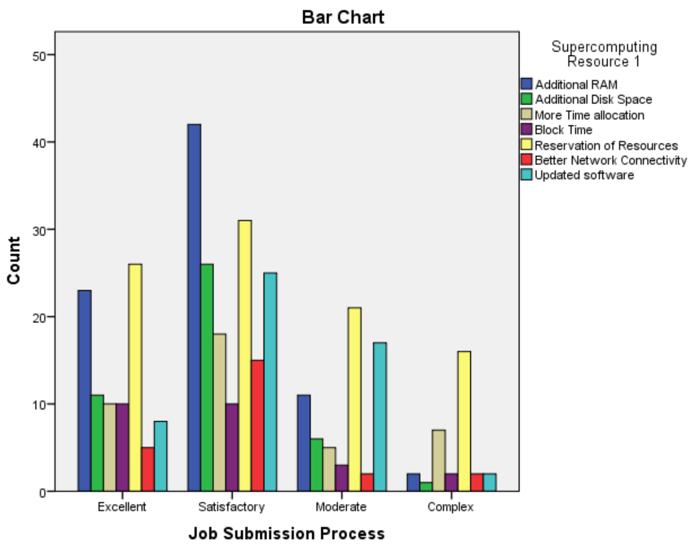


Figure 33 Job Submission Process vs Supercomputing Resource-1

The above cross Table-62 exhibits statistically significant dependency (p-value =0.002) between the Job Submission Process and Supercomputing Resource-1 are independent.

H1 – Job Submission Process and Supercomputing Resource-1are dependent

The Job Submission Process and Supercomputing Resource-1 are significant.

Security of Job * Nature of the Job

Table 61: Security of Job vs Nature of the Job

			Nature of the Job			Total
			Parallelizable	Serial	Both	
Security of Job	Good	Count	59	9	113	181
		Expected Count	72.8	6.0	102.2	181.0
	Excellent	Count	99	4	109	212
		Expected Count	85.2	7.0	119.8	212.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.737[a]	2	.008
Likelihood Ratio	9.835	2	.007
Linear-by-Linear Association	6.534	1	.011
N of Valid Cases	393		

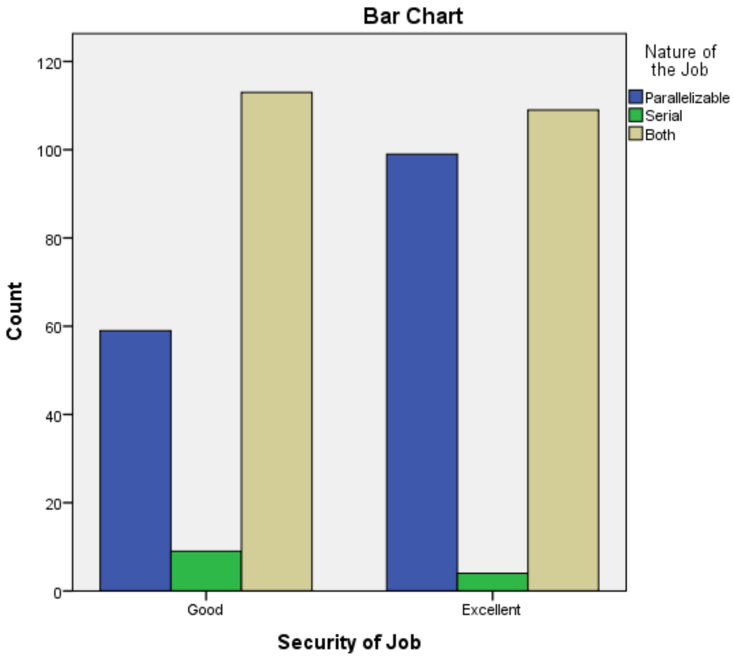


Figure 34 Security of Job vs Nature of the Job

The above cross Table-63 exhibits statistically significant dependency (p-value =0.008) between the Security of job and Nature of the job.

H0 – Security of job and Nature of the job are independent.

H1 – Security of job and Nature of the job are dependent

The Security of job and Nature of the job are significant.

Security of Job * Security of the Data

Table 62: Security of Job vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Security of Job	Good	Count	127	54	181
		Expected Count	100.9	80.1	181.0
	Excellent	Count	92	120	212
		Expected Count	118.1	93.9	212.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	28.359[a]	1	.000		
Continuity Correction[b]	27.285	1	.000		
Likelihood Ratio	28.842	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	28.287	1	.000		
N of Valid Cases	393				

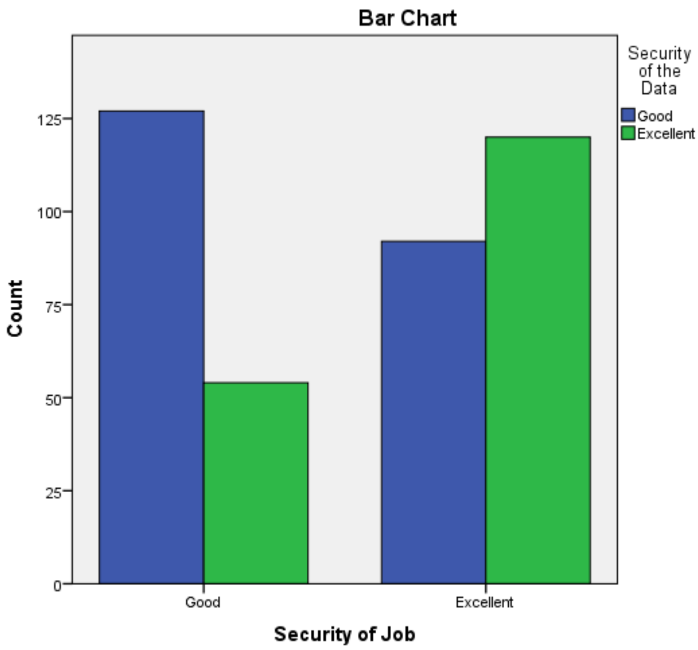


Figure 35 Security of Job vs Security of the Data

The above cross Table-64 exhibits statistically significant dependency (p-value =0.000) between the security of job and security of the data.

H0 – security of job and security of the data are independent.

H1 – security of job and security of the data are dependent

The security of job and security of the data are significant.

Security of Job * Supercomputing Resource-4

Table 63: Security of Job vs Supercomputing Resource-4

			Supercomputing Resource 4			Total
			Additional RAM	Additional Disk Space	More Time allocation	
Security of Job	Good	Count	15	12	0	27
		Expected Count	11.1	13.2	2.6	27.0
	Excellent	Count	6	13	5	24
		Expected Count	9.9	11.8	2.4	24.0
Total		Count	21	25	5	51
		Expected Count	21.0	25.0	5.0	51.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.751[a]	2	.013
Likelihood Ratio	10.780	2	.005
Linear-by-Linear Association	7.996	1	.005
N of Valid Cases	51		

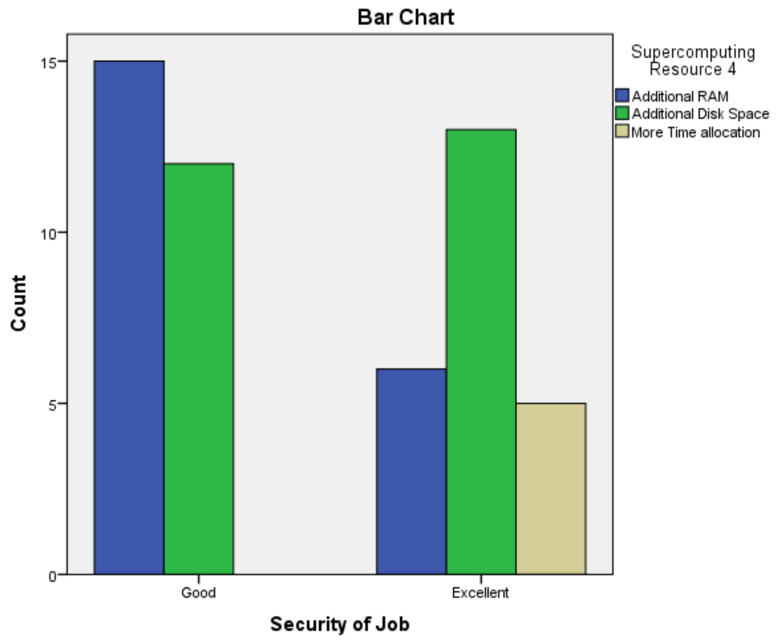


Figure 36 Security of Job vs Supercomputing Resource-4

The above cross Table-65 exhibits statistically significant dependency (p-value =0.013) between the Security of job and Supercomputing Resource-4.

H0 – Security of job and Supercomputing Resource-4 are independent.

H1 – Security of job and Supercomputing Resource-4 are dependent

The Security of job and Supercomputing Resource-4 are significant.

Security of the Data * Designation

Table 64: Security of the Data vs Designation

			Designation			Total
			Research Scholar	Faculty	Student	
Security of the Data	Good	Count	98	96	25	219
		Expected Count	96.4	88.6	34.0	219.0
	Excellent	Count	75	63	36	174
		Expected Count	76.6	70.4	27.0	174.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.827[a]	2	.033
Likelihood Ratio	6.796	2	.033
Linear-by-Linear Association	2.243	1	.134
N of Valid Cases	393		

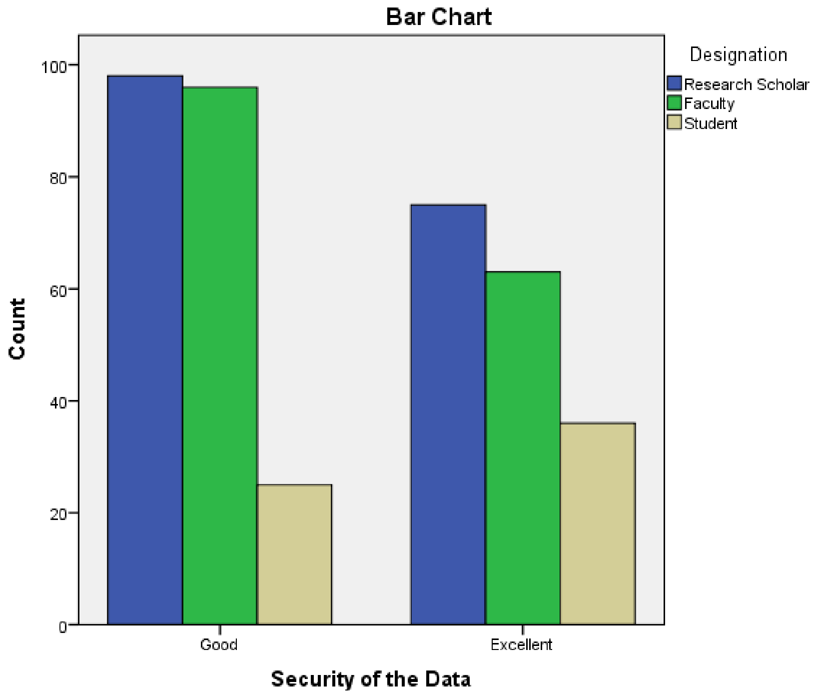


Figure 37 Security of the Data vs Designation

The above cross Table-66 exhibits statistically significant dependency (p-value =0.033) between the security of the data and Designation.

H0 – the security of the data and Designation are independent.

H1 – the security of the data and Designation are dependent

The security of the data and Designation are significant.

Security of the Data * Year of Register

Table 65: Security of the Data vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Security of the Data	Good	Count	61	31	18	27	14	14	28	26	219
		Expected Count	60.2	35.7	20.6	34.5	16.2	13.9	20.6	17.3	219.0
	Excellent	Count	47	33	19	35	15	11	9	5	174

		Expected Count	47.8	28.3	16.4	27.5	12.8	11.1	16.4	13.7	174.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.455[a]	7	.002
Likelihood Ratio	23.998	7	.001
Linear-by-Linear Association	8.855	1	.003
N of Valid Cases	393		

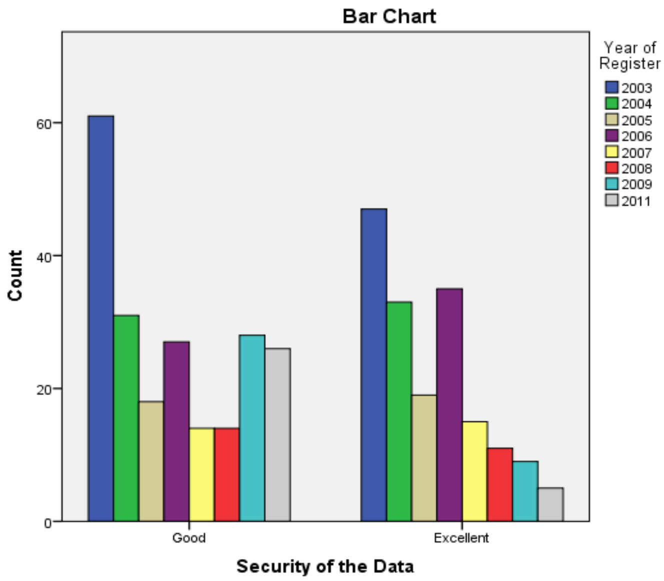


Figure 38 Security of the Data vs Year of Register

The above cross Table-67 exhibits statistically significant dependency (p-value = 0.002) between the security of the data and Year of Register.

H0 – security of the data and Year of Register are independent.

H1 – security of the data and Year of Register are dependent

The security of the data and Year of Register are significant.

Security of the Data * Use of HPC

Table 66: Security of the Data vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Security of the Data	Good	Count	106	87	20	6	219
		Expected Count	102.0	97.0	16.7	3.3	219.0
	Excellent	Count	77	87	10	0	174
		Expected Count	81.0	77.0	13.3	2.7	174.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.893[a]	3	.031
Likelihood Ratio	11.167	3	.011
Linear-by-Linear Association	.453	1	.501
N of Valid Cases	393		

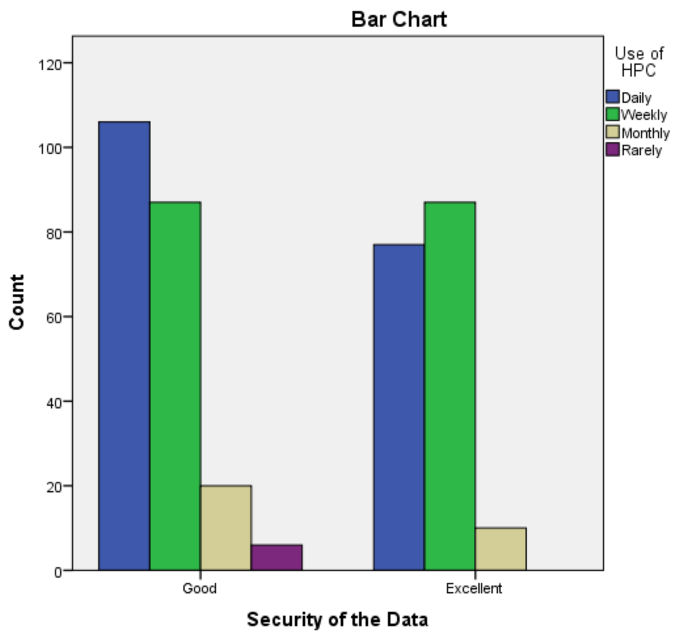


Figure 39 Security of the Data vs Use of HPC

The above cross Table-68 exhibits statistically significant dependency (p-value= 0.031) between the security of the data and Use of HPC.

H0 – security of the data and Use of HPC are independent.

H1 – security of the data and Use of HPC are dependent

The security of the data and Use of HPC are significant.

Security of the Data * Security of Job

Table 67: Security of the Data vs Security of Job

			Security of Job		
			Good	Excellent	Total
Security of the Data	Good	Count	127	92	219
		Expected Count	100.9	118.1	219.0
	Excellent	Count	54	120	174
		Expected Count	80.1	93.9	174.0
Total		Count	181	212	393
		Expected Count	181.0	212.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	28.359[a]	1	.000		
Continuity Correction[b]	27.285	1	.000		
Likelihood Ratio	28.842	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	28.287	1	.000		
N of Valid Cases	393				

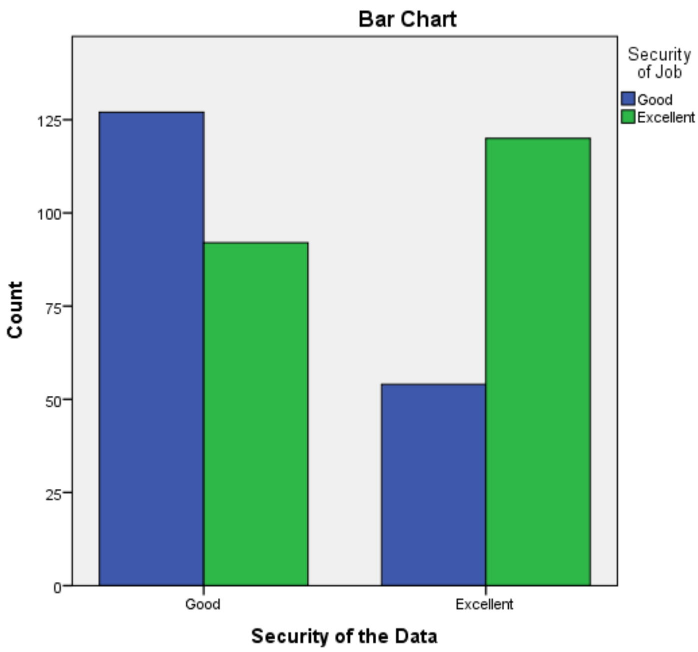


Figure 40 Security of the Data vs Security of Job

The above cross Table-69 exhibits statistically significant dependency (p-value =0.000) between the security of the data and Security of job.

H0 – security of the data and Security of job are independent.

H1 – security of the data and Security of job are dependent

The security of the data and Security of job are significant.

Infrastructural Facility * Designation

Table 68: Infrastructural Facility vs Designation

			Designation			Total
			Research Scholar	Faculty	Student	
Infrastructural Facility	3	Count	57	25	3	85
		Expected Count	37.4	34.4	13.2	85.0
	4	Count	102	119	52	273
		Expected Count	120.2	110.5	42.4	273.0
	5	Count	14	15	6	35
		Expected Count	15.4	14.2	5.4	35.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.156[a]	14	.000
Likelihood Ratio	53.213	14	.000
Linear-by-Linear Association	4.761	1	.029
N of Valid Cases	393		

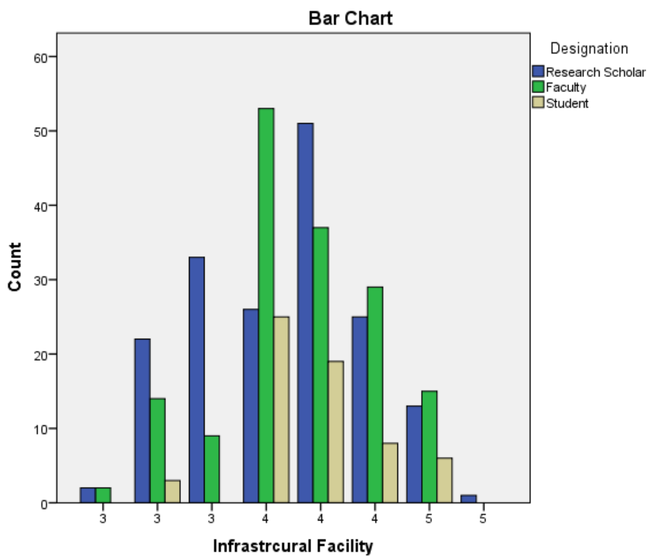


Figure 41 Infrastructural Facility vs Designation

The above cross Table-70 exhibits statistically significant dependency (p-value =0.000) between the Designation and Infrastructural Facility.

H0 – Designation and Infrastructural Facility are independent.

H1 – Designation and Infrastructural Facility are dependent

The Designation and Infrastructural Facility are significant.

Infrastructural Facility * Year of Register

Table 69: Infrastructural Facility vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Infrastructural Facility	3	Count	14	11	5	25	2	4	14	10	85
		Expected Count	23.4	13.8	8.0	13.4	6.3	5.4	8.0	6.7	85.0
	4	Count	84	50	29	30	23	18	19	20	273
		Expected Count	75.0	44.5	25.7	43.1	20.1	17.4	25.7	21.5	273.0
	5	Count	10	3	3	7	4	3	4	1	35
		Expected Count	9.6	5.7	3.3	5.5	2.6	2.2	3.3	2.8	35.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	93.451[a]	49	.000
Likelihood Ratio	90.047	49	.000
Linear-by-Linear Association	3.358	1	.067
N of Valid Cases	393		

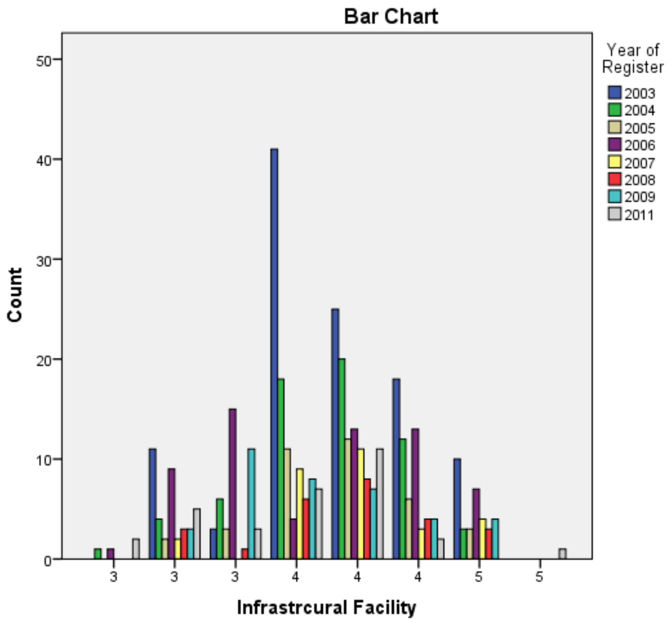


Figure 42 Infrastructural Facility vs Year of Register

The above cross Table-71 exhibits statistically significant dependency (p-value =0.001) between the Infrastructural Facility and Year of Register.

H0 – Infrastructural Facility and Year of Register are independent.

H1 – Infrastructural Facility and Year of Register are dependent.

The Infrastructural Facility and Year of Register are significant.

Infrastructural Facility * Use of HPC

Table 70: Infrastructural Facility vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Infrastructural Facility	3	Count	30	45	6	4	85
		Expected Count	39.6	37.6	6.5	1.3	85.0
	4	Count	130	121	20	2	273
		Expected Count	127.1	120.9	20.8	4.2	273.0
	5	Count	23	8	4	0	35
		Expected Count	16.3	15.5	2.7	.5	35.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.700[a]	21	.001
Likelihood Ratio	41.517	21	.005
Linear-by-Linear Association	7.754	1	.005
N of Valid Cases	393		

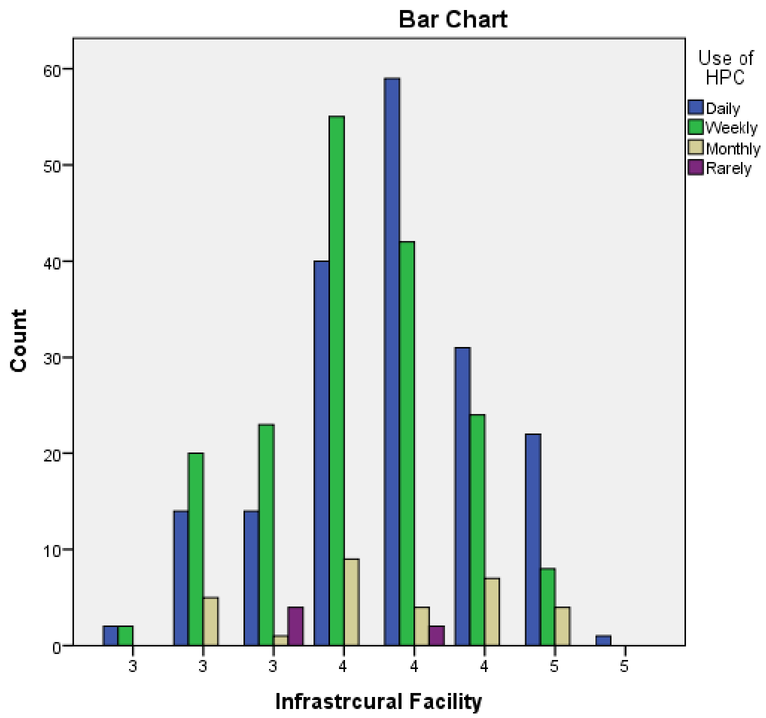


Figure 43 Infrastructural Facility vs Use of HPC

The above cross Table-72 exhibits statistically significant dependency (p-value =0.006) between the Infrastructural Facility and Use of HPC.

H0 – Infrastructural Facility and Use of HPC are independent.

H1 – Infrastructural Facility and Use of HPC are dependent.

The Infrastructural Facility and Use of HPC are significant.

Infrastructural Facility * Job Submission Process

Table 71: Infrastructural Facility vs Job Submission Process

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Infrastructural Facility	3	Count	20	43	19	3	85
		Expected Count	20.1	42.2	14.9	7.8	85.0
	4	Count	71	127	45	30	273
		Expected Count	64.6	135.5	47.9	25.0	273.0
	5	Count	2	25	5	3	35
		Expected Count	8.3	17.4	6.1	3.2	35.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.722[a]	21	.011
Likelihood Ratio	42.586	21	.004
Linear-by-Linear Association	2.466	1	.116
N of Valid Cases	393		

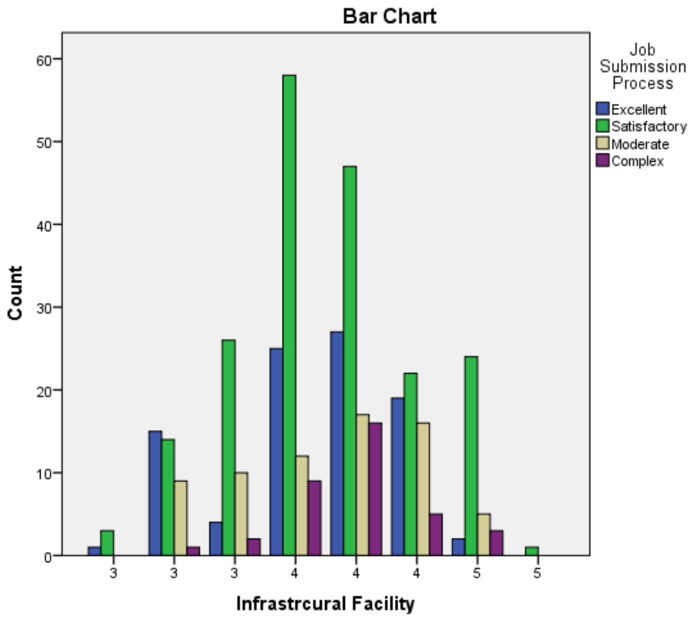


Figure 44 Infrastructural Facility vs Job Submission Process

The above cross Table-73 exhibits statistically significant dependency (p-value =0.022) between the Infrastructural Facility and Job Submission Process

H0 – Infrastructural Facility and Job Submission Process are independent.

H1 – Infrastructural Facility and Job Submission Process are dependent

The Infrastructural Facility and Job Submission Process are significant.

Infrastructural Facility * Security of the Data

Table 72: Infrastructural Facility vs Security of the Data

			Security of the Data		
			Good	Excellent	Total
Infrastructural Facility	3	Count	37	48	85
		Expected Count	47.4	37.6	85.0
	4	Count	157	116	273
		Expected Count	152.1	120.9	273.0
	5	Count	25	10	35
		Expected Count	19.5	15.5	35.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.329[a]	7	.005
Likelihood Ratio	20.951	7	.004
Linear-by-Linear Association	3.083	1	.079
N of Valid Cases	393		

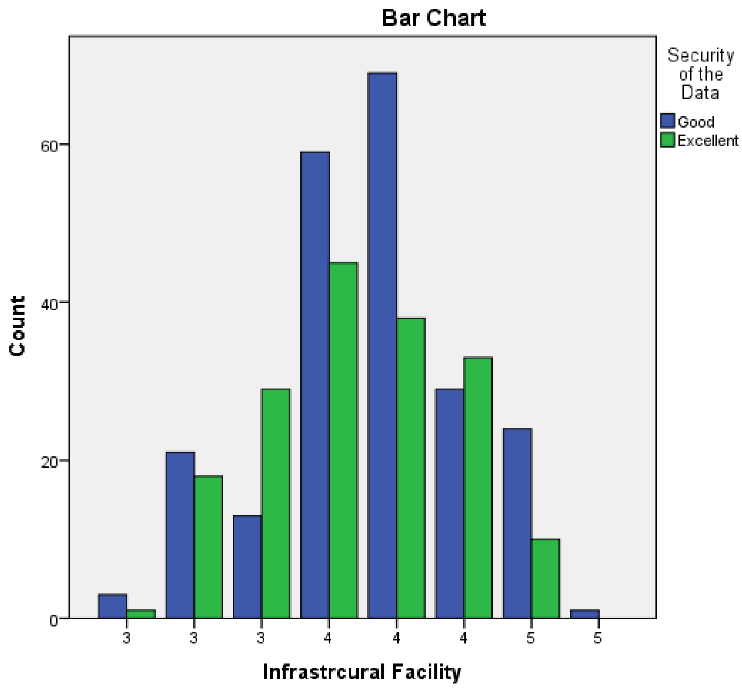


Figure 45 Infrastructural Facility vs Security of the Data

The above cross Table-74 exhibits statistically significant dependency (p-value =0.005) between the Infrastructural Facility and Security of the Data**.**

H0 – Infrastructural Facility and Security of the Data are independent.

H1 – Infrastructural Facility and Security of the Data are dependent.

The Infrastructural Facility and Security of the Data is significant.

Infrastructural Facility * Application Parallel or Serial

Table 73: Infrastructural Facility vs Application Parallel or Serial

	Application Parallel or Serial		Total
	Parallel	Serial	

Infrastructural Facility	3	Count	37	48	85
		Expected Count	50.6	34.4	85.0
	4	Count	170	103	273
		Expected Count	162.5	110.5	273.0
	5	Count	27	8	35
		Expected Count	20.8	14.2	35.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.516[a]	7	.007
Likelihood Ratio	19.937	7	.006
Linear-by-Linear Association	6.286	1	.012
N of Valid Cases	393		

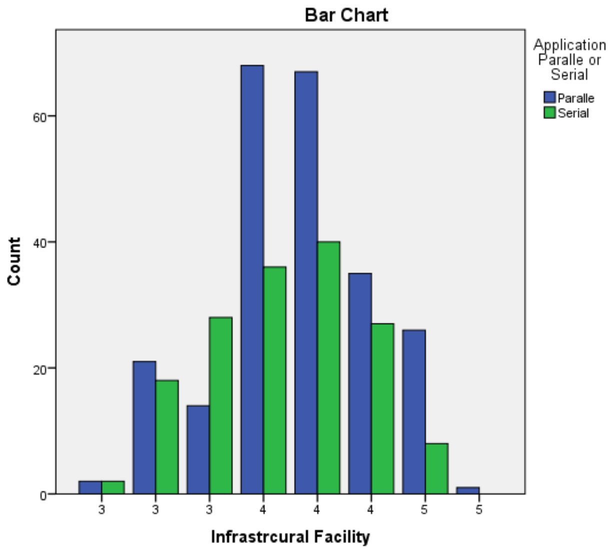


Figure 46 Infrastructural Facility vs Application Parallel or Serial

The above cross Table-75 exhibits statistically significant dependency (p-value =0.007) between the Infrastructural Facility and Application Parallel or Serial.

H0 – Infrastructural Facility and Application Parallel or Serial are independent.

H1 – Infrastructural Facility and Application Parallel or Serial are dependent.

The Infrastructural Facility and Application Parallel or Serial is significant.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Application Parallel or Serial * Organization	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Field of Research	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 2	361	91.9%	32	8.1%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 3	336	85.5%	57	14.5%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 4	336	85.5%	57	14.5%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 5	224	57.0%	169	43.0%	393	100.0%
Application Parallel or Serial * Year of Register	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Nature of the Job	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Financial Support	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Infrastructural Facility	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 1	357	90.8%	36	9.2%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 2	269	68.4%	124	31.6%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 3	115	29.3%	278	70.7%	393	100.0%

Application Parallel or Serial * Organization

Table 74: Application Parallel or Serial vs Organization

			Organization		
			UNIVERSITY OF HYDERABAD	Other	Total
Application Parallel or Serial	Parallel	Count	192	42	234
		Expected Count	199.5	34.5	234.0
	Serial	Count	143	16	159
		Expected Count	135.5	23.5	159.0
Total		Count	335	58	393
		Expected Count	335.0	58.0	393.0

The above cross Table-76 exhibits statistically significant dependency (p-value =0.031) between the Application Parallel or Serial and Organization.

H0 – Application Parallel or Serial and Organization are independent.

H1 – Application Parallel or Serial and Organization are dependent

The Application Parallel or Serial and Organization are significant.

Application Parallel or Serial * Field of Research

Table 75: Application Parallel or Serial vs Field of Research

			Field of Research							Total
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	
Application Parallel or Serial	Parallel	Count	18	42	79	70	17	4	4	234
		Expected Count	19.1	54.8	76.2	64.3	12.5	2.4	4.8	234.0
	Serial	Count	14	50	49	38	4	0	4	159
		Expected Count	12.9	37.2	51.8	43.7	8.5	1.6	3.2	159.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

The above cross Table-77 exhibits statistically significant dependency (p-value =0.014) between the Application Parallel or Serial and Field of Research.

H0 – Application Parallel or Serial and Field of Research are independent.

H1 – Application Parallel or Serial and Field of Research are dependent

The Application Parallel or Serial and Field of Research are significant.

Application Parallel or Serial * Group of Software Packages Used-2

Table 76: Application Parallel or Serial vs Group of Software Packages Used-2

	Group of Software Packages Used-2	Total

			Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Economics Software	
Application Parallel or Serial	Parallel	Count	149	29	34	4	216
		Expected Count	141.2	40.1	32.3	2.4	216.0
	Serial	Count	87	38	20	0	145
		Expected Count	94.8	26.9	21.7	1.6	145.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

The above cross Table-78 exhibits statistically significant dependency (p-value =0.009) between the Application Parallel or Serial and Group Software Packages Used-2.

H0 – Application Parallel or Serial and Group Software Packages Used-2 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-2 are dependent

The Application Parallel or Serial and Group Software Packages Used-2 are significant.

Application Parallel or Serial * Group of Software Packages Used-3

Table 77: Application Parallel or Serial vs Group of Software Packages Used-3

			Group of Software Packages Used-3			
			Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Software Packages-Chem/Physics/Enng Science	Total
Application Parallel or Serial	Parallel	Count	149	4	42	195
		Expected Count	137.0	5.8	52.2	195.0
	Serial	Count	87	6	48	141
		Expected Count	99.0	4.2	37.8	141.0
Total		Count	236	10	90	336
		Expected Count	236.0	10.0	90.0	336.0

The above cross Table-79 exhibits statistically significant dependency (p-value =0.013) between the Application Parallel or Serial and Group Software Packages Used-3.

H0 – Application Parallel or Serial and Group Software Packages Used-3 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-3 are dependent

The Application Parallel or Serial and Group Software Packages Used-3 are significant.

Application Parallel or Serial * Group of Software Packages Used-4

Table 78: Application Parallel or Serial vs Group of Software Packages Used-4

			Group of Software Packages Used-4				
			Economics Software	Software Packages-Chem/Physics/Enng Science	Software Packages - Life science	Software Packages - Physics Chemistry	Total
Application Parallel or Serial	Parallel	Count	4	79	70	42	195
		Expected Count	5.8	74.3	62.7	52.2	195.0
	Serial	Count	6	49	38	48	141
		Expected Count	4.2	53.7	45.3	37.8	141.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

The above cross Table-80 exhibits statistically significant dependency (p-value =0.031) between the Application Parallel or Serial and Group Software Packages Used-4.

H0 – Application Parallel or Serial and Group Software Packages Used-4 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-4 are dependent

The Application Parallel or Serial and Group Software Packages Used-4 are significant.

Application Parallel or Serial * Group of Software Packages Used-5

Table 79: Application Parallel or Serial vs Group of Software Packages Used-5

			Group of Software Packages Used-5			Total
			Software Packages - Physics Chemistry	Software Packages - Electronics and Physics	Software Packages - Maths/Physics/Electronics	
Application Parallel or Serial	Parallel	Count	79	0	42	121
		Expected Count	69.1	2.2	49.7	121.0
	Serial	Count	49	4	50	103
		Expected Count	58.9	1.8	42.3	103.0
Total		Count	128	4	92	224
		Expected Count	128.0	4.0	92.0	224.0

The above cross Table-81 exhibits statistically significant dependency (p-value =0.006) between the Application Parallel or Serial and Group Software Packages Used-5.

H0 – Application Parallel or Serial and Group Software Packages Used-5 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-5are dependent

The Application Parallel or Serial and Group Software Packages Used-5 are significant.

Application Parallel or Serial * Year of Register

Table 80: Application Parallel or Serial vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
	Parallel	Count	69	28	21	44	19	16	17	20	234

Application Parallel or Serial		Expected Count	64.3	38.1	22.0	36.9	17.3	14.9	22.0	18.5	234.0
	Serial	Count	39	36	16	18	10	9	20	11	159
		Expected Count	43.7	25.9	15.0	25.1	11.7	10.1	15.0	12.5	159.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

The above cross Table-82 exhibits statistically significant dependency (p-value =0.039) between the Application Parallel or Serial and Year of Register.

H0 – Application Parallel or Serial and Year of Register are independent.

H1 – Application Parallel or Serial and Year of Register are dependent

The Application Parallel or Serial and Year of Register are significant.

Application Parallel or Serial * Nature of the Job

Table 81: Application Parallel or Serial vs Nature of the Job

			Nature of the Job			Total
			Parallelizable	Serial	Both	
Application Parallel or Serial	Parallel	Count	113	7	114	234
		Expected Count	94.1	7.7	132.2	234.0
	Serial	Count	45	6	108	159
		Expected Count	63.9	5.3	89.8	159.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

The above cross Table-83 exhibits statistically significant dependency (p-value =0.000) between the Application Parallel or Serial and Nature of the Job.

H0 – Application Parallel or Serial and Nature of the Job are independent.

H1 – Application Parallel or Serial and Nature of the Job are dependent

The Application Parallel or Serial and Nature of the Job are significant.

Application Parallel or Serial * Financial Support

Table 82: Application Parallel or Serial vs Financial Support

			Financial Support		Total
			Funding Agency	University - HPC	
	Parallel	Count	63	171	234

Application Parallel or Serial		Expected Count	75.0	159.0	234.0
	Serial	Count	63	96	159
		Expected Count	51.0	108.0	159.0
Total		Count	126	267	393
		Expected Count	126.0	267.0	393.0

The above cross Table-84 exhibits statistically significant dependency (p-value =0.008) between the Application Parallel or Serial and Financial Support.

H0 – Application Parallel or Serial and Financial Support are independent.

H1 – Application Parallel or Serial and Financial Support are dependent

The Application Parallel or Serial and Financial Support are significant.

Application Parallel or Serial * Supercomputing Resource-1

Table 83: Application Parallel or Serial vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Application Parallel or Serial	Parallel	Count	47	26	28	11	73	12	27	224
		Expected Count	48.9	27.6	25.1	15.7	59.0	15.1	32.6	224.0
	Serial	Count	31	18	12	14	21	12	25	133
		Expected Count	29.1	16.4	14.9	9.3	35.0	8.9	19.4	133.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

The above cross Table-85 exhibits statistically significant dependency (p-value =0.005) between the Application Parallel or Serial and Supercomputing Resource-1.

H0 – Application Parallel or Serial and Supercomputing Resource-1 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-1 are dependent

The Application Parallel or Serial and Supercomputing Resource-1 are significant.

Application Parallel or Serial * Supercomputing Resource-2

Table 84: Application Parallel or Serial vs Supercomputing Resource-2

			Supercomputing Resource-2							Total
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	
Application Parallel or Serial	Parallel	Count	33	23	11	64	16	17	5	169
		Expected Count	43.3	22.0	17.0	50.9	13.8	18.8	3.1	169.0
	Serial	Count	36	12	16	17	6	13	0	100
		Expected Count	25.7	13.0	10.0	30.1	8.2	11.2	1.9	100.0
Total		Count	69	35	27	81	22	30	5	269
		Expected Count	69.0	35.0	27.0	81.0	22.0	30.0	5.0	269.0

The above cross Table-86 exhibits statistically significant dependency (p-value =0.000) between the Application Parallel or Serial and Supercomputing Resource-2.

H0 – Application Parallel or Serial and Supercomputing Resource-2 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-2 are dependent

The Application Parallel or Serial and Supercomputing Resource-2 are significant.

Application Parallel or Serial * Supercomputing Resource-3

Table 85: Application Parallel or Serial vs Supercomputing Resource-3

			Supercomputing Resource -3					Total
			Additional RAM	Additional Disk Space	More Time allocation	Reservation of Resources	Updated software	
Application Parallel or Serial	Parallel	Count	22	4	24	12	5	67
		Expected Count	29.1	2.9	17.5	14.6	2.9	67.0
	Serial	Count	28	1	6	13	0	48
		Expected Count	20.9	2.1	12.5	10.4	2.1	48.0
Total		Count	50	5	30	25	5	115
		Expected Count	50.0	5.0	30.0	25.0	5.0	115.0

The above cross Table-87 exhibits statistically significant dependency (p-value =0.004) between the Application Parallel or Serial and Supercomputing Resource-3.

H0 – Application Parallel or Serial and Supercomputing Resource-3 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-3 are dependent

The Application Parallel or Serial and Supercomputing Resource-3 are significant.

HPC Rating * Use of HPC

Table 86: HPC Rating vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
HPC Rating	3	Count	9	13	8	0	30
		Expected Count	14.0	13.3	2.3	.5	30.0
	4	Count	168	156	22	6	352
		Expected Count	163.9	155.8	26.9	5.4	352.0
	5	Count	6	5	0	0	11
		Expected Count	5.1	4.9	.8	.2	11.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	99.918[a]	36	.000
Likelihood Ratio	86.053	36	.000
Linear-by-Linear Association	15.790	1	.000
N of Valid Cases	393		

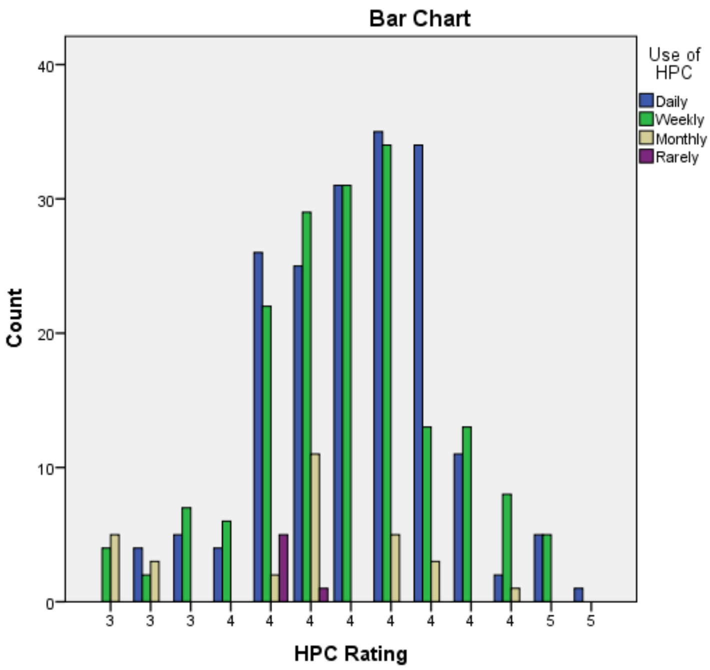


Figure 47 HPC Rating vs Use of HPC

The above cross Table-88 exhibits statistically significant dependency (p-value =0.000) between the HPC Rating and Use of HPC.

H0 – HPC Rating and Use of HPC are independent.

H1 – HPC Rating and Use of HPC are dependent

The HPC Rating and Use of HPC are significant.

5.4 Hypothesis and Inference

According to the problem of study, the following null hypotheses are formulated to analysis the system, to arrive the answers to some of questions.

The e-CRM effect pertaining to software packages availability, accessing facility, usage of facility, personalization and fulfillment of requirements on customer satisfaction in HPCF.

H_0^1: There is no significant effect of the software packages availability on customer satisfaction in HPCF.

H_0^2: There is no significant effect of the accessing facility on customer satisfaction in HPCF.

H_0^3: There is no significant effect of the usage of facility on customer satisfaction in HPCF.

H_0^4: There is no significant effect of the personalization on customer satisfaction in HPCF.

H_0^5: There is no significant effect of the fulfillment of requirements on customer satisfaction in HPCF.

<u>Inference</u>

H_0^1: From the contingency analysis given Table-33 it explains the rejection of the Null Hypothesis.

There is a significant positive effect of Group of Software Packages used 2 on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^2: From the contingency analysis given Table-40 one can reject the Null Hypothesis.

There is a significant positive effect of accessing facility on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^3: From the contingency analysis given Table-48 it reveals that the rejection of the Null Hypothesis.

There is a significant positive effect of usage of facility on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^4: From the contingency analysis given Table-56 Explains the Rejection of the Null Hypothesis.

There is a significant positive effect of the personalization on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^5: From the contingency analysis given Table-55 it reveals the Rejection of the Null Hypothesis.

There is a significant positive effect of the fulfillment of requirements on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

5.5 Quantitative Analysis

Rating among the Over the attributes

The HPC rating and infrastructural rating is derived from the items of questionnaire which are given in 5 point scale has been treated as continuous measure and the analysis over the various characteristics have been carried out in this section.

The significant of attribute reveled a significant one-way analysis are organized in the following sub sections first infrastructural rating another for HPC rating.

Infrastructural rating

The analysis against the usage pattern showed significant infrastructural mean rating. Thus daily users are more satisfied by the infrastructural facility on the average over the weekly.

5.5.1 Job Submission

Table 87: Infrastructural Facility - Descriptive

					95% Confidence Interval for Mean		
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum

Daily	193	3.91	.484	.035	3.84	3.98	3
Weekly	200	3.77	.463	.033	3.71	3.84	3
Total	393	3.84	.477	.024	3.79	3.89	3

Table 88: Infrastructural Facility - ANOVA

	Sum of squares	df	Mean Square	F	Sig.
Between Groups	1.840	1	1.840	8.220	.004
Within Groups	87.501	391	.224		
Total	89.341	392			

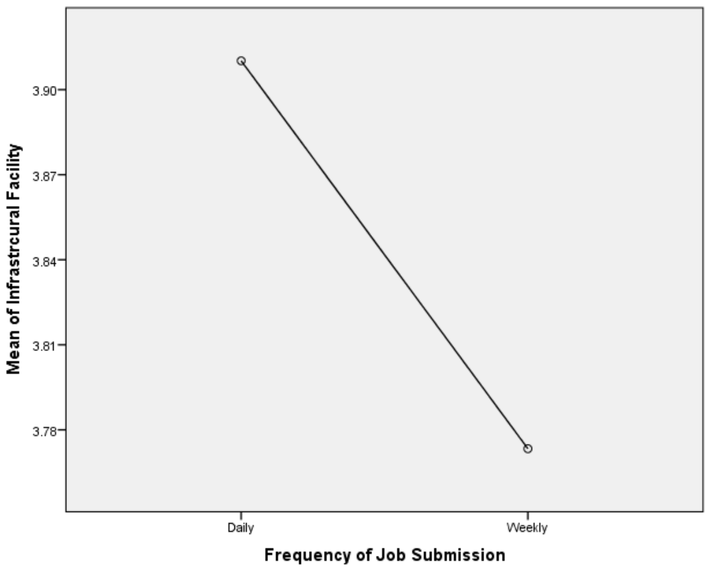
The above analysis exhibits statistically significant dependency (p-value =0.004) among usage pattern.

Daily usage users rated significantly high for Infrastructural Facility compare to weekly.

This may be because of the awareness of the Infrastructural facility by the frequent users than periodical users.

Workshops on Infrastructural facilities, training are expected to may enhance rating and will improve customer relationship management.

Means Plots of Frequency of Job Submission



5.5.2 HPC Users

Table 89: Infrastructural Facility Descriptive

Infrastructural Facility

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Daily	183	3.93	.477	.035	3.86	4.00	3	5
Weekly	174	3.75	.453	.034	3.69	3.82	3	5
Monthly	30	3.88	.543	.099	3.68	4.08	3	5
Rarely	6	3.56	.344	.141	3.19	3.92	3	4
Total	393	3.84	.477	.024	3.79	3.89	3	5

ANOVA

Infrastructural Facility

	Sum of Squares	df	Mean Square	F
Between Groups	3.239	3	1.080	4.877
Within Groups	86.102	389	.221	
Total	89.341	392		

The above analysis exhibits statistically significant dependency (p-value =0.002) among usage pattern.

Daily HPC users rated significantly high for Infrastructural Facility compare to weekly.

This may be because of the awareness of the Infrastructural facility by the frequent users than periodical users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will to the improve customer relationship management

Mean rating of Infrastructural Facility daily use of HPC is 3.93(0.035) which is statically significantly high than weekly mean rate 3.75(.034).

The rarely HPC users mean rate 3.56(0.141) is not statically low due to the higher standard error, whereas monthly users of HPC facility are statically in-significant in rating. This needs an investigation management strategy to enhance rating by weekly users.

Table 90: Dependent Variable: Infrastructural Facility

Multiple Comparisons

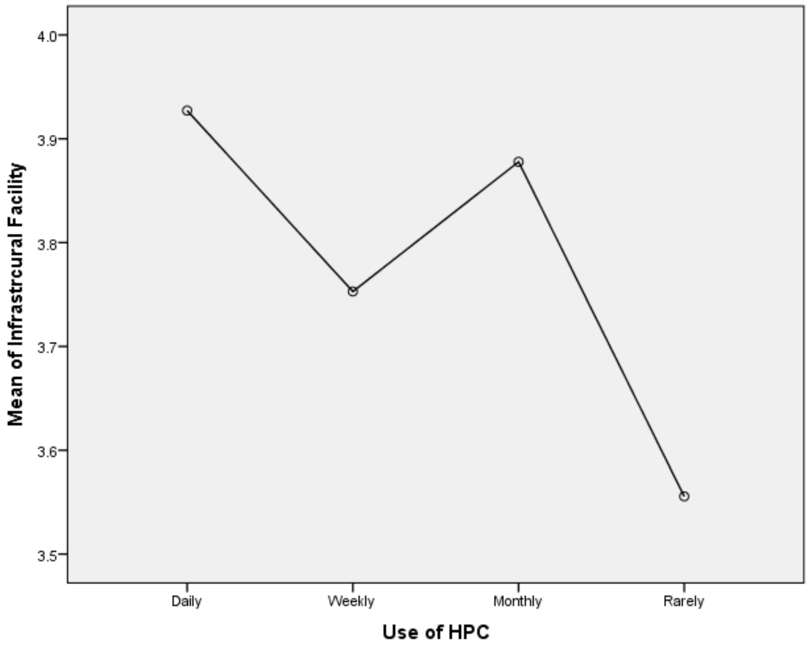
Dependent Variable: Infrastructural Facility

LSD

(I) Use of HPC	(J) Use of HPC	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Daily	Weekly	.174*	.050	.001	.08	.27
	Monthly	.049	.093	.595	-.13	.23
	Rarely	.372	.195	.058	-.01	.76
Weekly	Daily	-.174*	.050	.001	-.27	-.08
	Monthly	-.125	.093	.180	-.31	.06
	Rarely	.197	.195	.313	-.19	.58
Monthly	Daily	-.049	.093	.595	-.23	.13
	Weekly	.125	.093	.180	-.06	.31
	Rarely	.322	.210	.126	-.09	.74
Rarely	Daily	-.372	.195	.058	-.76	.01
	Weekly	-.197	.195	.313	-.58	.19
	Monthly	-.322	.210	.126	-.74	.09

*. The mean difference is significant at the 0.05 level.

Means Plot of Use of HPC



5.5.3 Type of application

Table 91: Infrastructural Facility

Descriptive								
Infrastructural Facility								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Parallel	234	3.89	.472	.031	3.83	3.95	3	5
Serial	159	3.77	.477	.038	3.69	3.84	3	5
Total	393	3.84	.477	.024	3.79	3.89	3	5

ANOVA					
Infrastructural Facility					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.433	1	1.433	6.372	.012
Within Groups	87.908	391	.225		

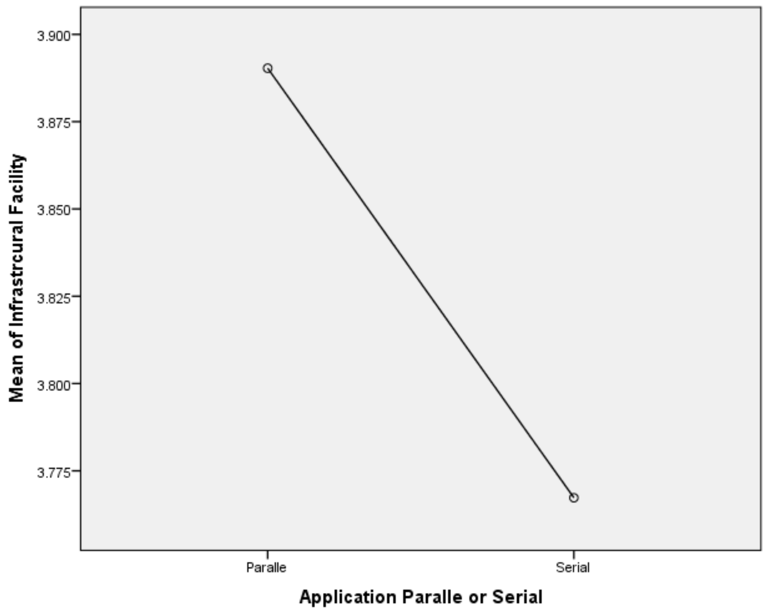
Total	89.341	392			

The above analysis exhibits statistically significant dependency (p-value 0.012) among usage pattern.

Parallel job users rated significantly high for Infrastructural Facility compare to Serial job users. This may be because of the awareness of the Infrastructural facility by the Parallel job users than serial job users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will improve customer relationship management

Means Plots of Application Parallel or Serial



5.5.4 HPC Rating

5.5.4.1 Field of study

Table 92: Field of study HPC Rating

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
School of Mathematics and Statistics	32	3.94	.180	.032	3.88	4.01	4	4

School of Physics	92	3.91	.313	.033	3.85	3.98	3	5
School of Chemistry	128	3.84	.302	.027	3.79	3.90	3	5
School of Life Sciences	108	3.83	.330	.032	3.76	3.89	3	5
School of Engineering Sciences and Technology	21	3.84	.299	.065	3.70	3.98	3	4
School of Economics	4	4.25	.000	.000	4.25	4.25	4	4
School of Computer and Information Sciences	8	3.88	.094	.033	3.80	3.95	4	4
Total	393	3.87	.304	.015	3.84	3.90	3	5

ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.222	6	.204	2.245	.038
Within Groups	35.019	386	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value =0.038) among usage pattern.

School of Economics users rated significantly high for HPC Rating compare to other school users. This may be because of the awareness of the HPC Rating by the School of Economics users than other school users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will improve customer relationship management

Mean rating of HPC Rating of School of Economics is 4.25(0.000) which is statically significantly high than other schools.

The School of Life Sciences users HPC Rating mean rate 3.89(0.032) is low

The users of the School of Economics are consistent.

Post Hoc Tests

Multiple Comparisons

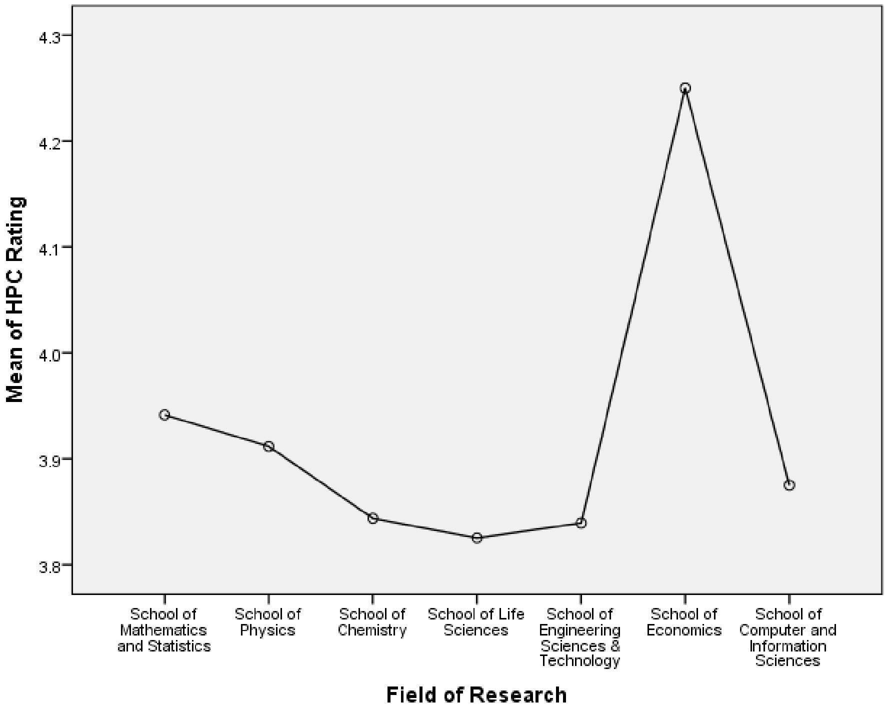
Dependent Variable: HPC Rating
LSD

(I) Field of Research	(J) Field of Research	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
School of Mathematics and Statistics	School of Physics	.030	.062	.631	-.09	.15
	School of Chemistry	.098	.060	.102	-.02	.21
	School of Life Sciences	.116	.061	.056	.00	.24
	School of Engineering Sciences and Technology	.102	.085	.228	-.06	.27
	School of Economics	-.309	.160	.054	-.62	.01
	School of Computer and Information Sciences	.066	.119	.577	-.17	.30
School of Physics	School of Mathematics and Statistics	-.030	.062	.631	-.15	.09
	School of Chemistry	.068	.041	.100	-.01	.15
	School of Life Sciences	.086*	.043	.044	.00	.17
	School of Engineering Sciences and Technology	.072	.073	.321	-.07	.22
	School of Economics	-.338*	.154	.028	-.64	-.04
	School of Computer and Information Sciences	.037	.111	.741	-.18	.25
School of Chemistry	School of Mathematics and Statistics	-.098	.060	.102	-.21	.02
	School of Physics	-.068	.041	.100	-.15	.01
	School of Life Sciences	.019	.039	.638	-.06	.10
	School of Engineering Sciences and Technology	.004	.071	.950	-.13	.14
	School of Economics	-.406*	.153	.008	-.71	-.11
	School of Computer and Information Sciences	-.031	.110	.776	-.25	.18

School of Life Sciences	School of Mathematics and Statistics	-.116	.061	.056	-.24	.00
	School of Physics	-.086*	.043	.044	-.17	.00
	School of Chemistry	-.019	.039	.638	-.10	.06
	School of Engineering Sciences and Technology	-.014	.072	.845	-.16	.13
	School of Economics	-.425*	.153	.006	-.73	-.12
	School of Computer and Information Sciences	-.050	.110	.652	-.27	.17
School of Engineering Sciences and Technology	School of Mathematics and Statistics	-.102	.085	.228	-.27	.06
	School of Physics	-.072	.073	.321	-.22	.07
	School of Chemistry	-.004	.071	.950	-.14	.13
	School of Life Sciences	.014	.072	.845	-.13	.16
	School of Economics	-.411*	.164	.013	-.73	-.09
	School of Computer and Information Sciences	-.036	.125	.775	-.28	.21
School of Economics	School of Mathematics and Statistics	.309	.160	.054	-.01	.62
	School of Physics	.338*	.154	.028	.04	.64
	School of Chemistry	.406*	.153	.008	.11	.71
	School of Life Sciences	.425*	.153	.006	.12	.73
	School of Engineering Sciences and Technology	.411*	.164	.013	.09	.73
	School of Computer and Information Sciences	.375*	.184	.043	.01	.74
School of Computer and Information Sciences	School of Mathematics and Statistics	-.066	.119	.577	-.30	.17
	School of Physics	-.037	.111	.741	-.25	.18
	School of Chemistry	.031	.110	.776	-.18	.25
	School of Life Sciences	.050	.110	.652	-.17	.27
	School of Engineering Sciences and Technology	.036	.125	.775	-.21	.28
	School of Economics	-.375*	.184	.043	-.74	-.01

*. The mean difference is significant at the 0.05 level.

Means Plots of Field of Research



5.5.4.2 Usage period

Table 93: HPC Rating Usage period

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
2-4 Years	8	4.16	.129	.046	4.05	4.26	4	4
> 4 Years	385	3.86	.304	.015	3.83	3.89	3	5
Total	393	3.87	.304	.015	3.84	3.90	3	5

ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.683	1	.683	7.510	.006
Within Groups	35.558	391	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value 0.006) among usage pattern.

Means Plots of HPC Usage Period

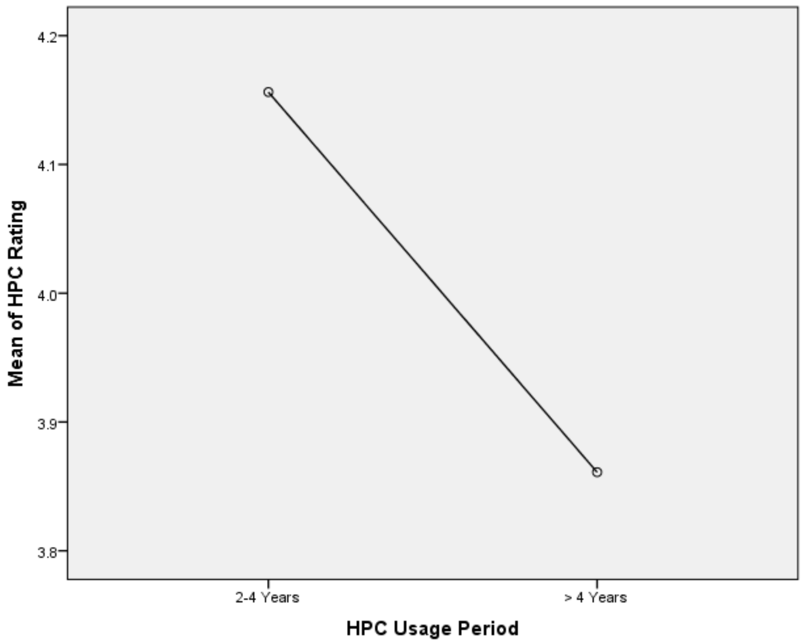


Table 94: HPC Rating Organization

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Funding Agency	126	3.81	.308	.027	3.76	3.87	3	5
University - HPC	267	3.89	.300	.018	3.86	3.93	3	5
Total	393	3.87	.304	.015	3.84	3.90	3	5

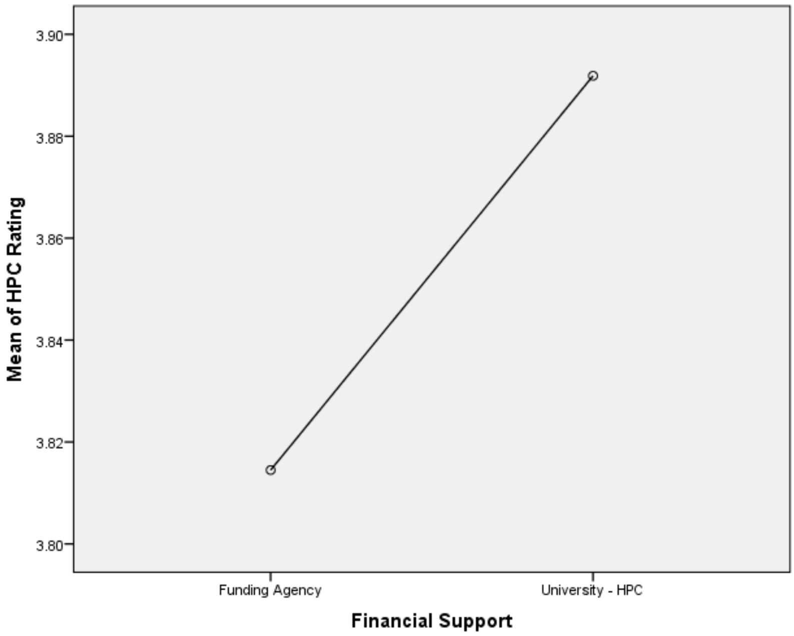
ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.512	1	.512	5.608	.018
Within Groups	35.728	391	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value 0.018) among usage pattern.

Means Plots of Financial Support


Mean of HPC Rating
3.90
3.88
3.86
3.84
3.82
3.80
Funding Agency
University - HPC
Financial Support

5.6 Summary

The data which is organized in SPSS has been analyzed mainly frequency analysis, contingency analysis and analysis of variance by using SPSS scarping language.

Some of the observations are as follows:

The significant association has been revealed most of the cases the particular users like faculty, scientists looks better and safety storage. While the researchers like research scholar and research assistants for fixed period looks more enhanced RAM facility for efficient computational power.

Managing security and storage issues are exposed to give better Customer Relationship. However enhance the RAM for better customer relation to the fixed period users like research scholars can be addressed with the current day technology by adopting the cloud solutions.

The infrastructural facility rating to improve HPC Center need conduct awareness programmes to the users. Give training in the related felids to convert the serial job users to the parallel job users so they can use HPC very optimally.

The user are requires the guidance to use the HPC facility, so that they can get the maximum benefits of the systems. It also gives raise to the HPC rating.

Workshops on Infrastructural facilities, training are expected to enhance rating and will improve customer relationship management.

5 Data Analysis

5.1 Data Analysis Techniques

Data has been analyzed using statistical such as ANOVA, Chi-square test, Spearman's Rank Correlation, Regression analysis, Factor analysis and simple statistics such as average and mean. SPSS is used to facilitate the same.

5.1.1 ANOVA Test

The analysis of variance, popularly known as the ANOVA test is used in cases when there are more than two groups. "Analysis of variance (ANOVA) is a statistical technique that can be used to evaluate whether there is a differences in the average value or mean, across several population groups. With this model, the response variable is continuous in nature whereas the predictor variables are categorical". When there are only two samples one can use the t-test to compare the means of the samples but it might become unreliable in case of more than two samples. If only two means are compared, then the t-test (independent samples) will give the same result as the ANOVA. It is used to compare the means of more than two samples. "In statistics, analysis of variance (ANOVA) is a collection of statistical models, and their associated procedures, in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation. In its simplest form ANOVA provides a statistical test of whether or not the means of several groups are all equal, and therefore generalizes t-test to more than two groups. ANOVA's are helpful because they possess an advantage over a two sample t-test. Doing multiple two-sample t-test would result in an increased chance of committing a type-I error. For this reason, ANOVA's are useful in comparing three or more means".

The purpose of ANOVA test is to determine the existence, or absence of a statistically significant difference amongst several group means. ANOVA actually uses variances to help determine if the various means are equal or not.

To perform ANOVA test three basic assumption must be fulfilled.

- Each group which the sample is taken is normal
- Each group is randomly selected and independent.
- The variables from each group come from distribution with approximately equal standard deviation.

One-way ANOVA: One way ANOVA is used when there is only one category whose effect has been studied and balanced. Thus the basic idea is to test whether the samples are all alike or not. "One-way ANOVA evaluates the effect of a single factor on a single response variable. Using ANOVA to make this comparison requires that several assumptions be satisfied. Specifically the sample must be selected randomly from each of the population groups, a value for the response variable is recorded for each sampled respondent, the distribution of the response variable is normally distributed in each population, and the variance of the response variable is the same in each population". As indicated through its designation, ANOVA compares mean by using estimates of variance. Specifically, the sampled observations can be described in terms of the variation of the individual values around their group means, and of the variation of the group means around the overall mean. These measures are frequently referred to as source of "within groups" and "between groups" variability, respectively. If the variability within the *k* different population is small relative to the variability between the group means, this suggests that the population means are different". This is formally tested using attest of significance based on the *F* distribution, which test the null hypothesis (Ho) that the means of the *k* groups are equal.

Ho = $\mu 1 = \mu 2 = \mu 3 = \ldots\ldots \mu k$

An "*F*- test is constructed by taking the ratio of the "between-groups" variation to the "within-groups" variation. If *n* represent the total number of sampled observations, this ratio has an F distribution with *k-1* and *n-k* degrees in the numerator and denominator, respectively. Under the null hypothesis, the within-groups and between-groups variance both estimate the same underlying population variance and the F ratio is close to one. If the between-groups variance is much larger than the within-groups, the F ratio become large and the associated *p-value* becomes small. This lead to rejection of the null hypothesis, thereby concluding that the means of the groups are not all equal. When interpreting the results from the ANOVA procedures it is helpful to comment on the strength of the observed association, as significant differences may result simply from having a very large number of samples".

5.1.2 Chi-Square test

The chi-square (I) test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. The chi-square is one of the most popular statistics because it is easy to calculate and interpret. There are two kinds of chi-square tests. The first is called a one-way analysis, and the second is called a two-way analysis. The purpose of both is to determine whether the observed frequencies (counts) markedly differ from the frequencies that we would expect by chance.

A "chi-square test (also chi squared test or χ^2 test) is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-square distribution when the null hypothesis is true, or any in which this is asymptotically true, meaning that the sampling distribution (if null hypothesis is true) can be made to approximate a chi-square distribution as closely as desired by making the sample size large enough". The chi-square (χ^2) test measures the alignment between two sets of frequency measures. These must be categorical counts and not percentages or ratios measures (for these, use another correlation test).

Goodness of fit: A common use to assess whether a measured/observed set of measures follows an expected pattern. The expected frequency may be determined from prior knowledge (such as previous year's exam results) or by calculation of an average for the given data. The null hypothesis, Ho is that the two sets of measures are not significantly different.

Independence: The chi-square test can be used in the reverse manner to goodness of fit. If the two sets of measures are compared, then just as you can show they align, you can also determine if they do not align. The null hypothesis here is that the two sets of measures are similar. The main difference in goodness-of-fit vs. independence assessment is in the use of the Chi Square table.

5.2 Frequency Analysis

The section consists of Frequency analysis and interpretation that is facilitated SPSS package. The analysis is presented findings, analysis and interpretation responses of the community under the study. The section is presented using tables; charts and interpretation which are drawn in the light of the findings.

5.2.1 Frequency Table

Table 1: Designation Organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	UNIVERSITY OF HYDERABAD	335	85.2	85.2	85.2
		58	14.8	14.8	100.0
		393	100.0	100.0	

Table 2: Designation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Research Scholar	173	44.0	44.0	44.0
	Faculty	159	40.5	40.5	84.5
	Student	61	15.5	15.5	100.0
	Total	393	100.0	100.0	

One can notice from the table that 80% user are using from the workplace or home rather than coming to the center. This is essential component for needing of current day needs. In this regard the infrastructure should be sophisticated seamless virtual activities. Further management challenges possess specific to virtual support, virtual guidance and training for this purpose the skilled professional of HPC should also develop skills to exhibit their support to remote user also.

Table 3: Field of Research

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	School of Mathematics and Statistics	32	8.1	8.1	8.1
	School of Physics	92	23.4	23.4	31.6
	School of Chemistry	128	32.6	32.6	64.1
	School of Life Sciences	108	27.5	27.5	91.6
	School of Engineering Sciences and Technology	21	5.3	5.3	96.9
	School of Economics	4	1.0	1.0	98.0
	School of Computer and Information Sciences	8	2.0	2.0	100.0
	Total	393	100.0	100.0	

The school of chemistry are having the 32.6%, school of life science are 27.5% school of physics 23.4% other schools are having the single digit percent. It shows that the users are more acquainted with HPC systems.

Table 4: Group of Software Packages Used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Software Packages- Chem-Life Sciences	236	60.1	65.4	65.4
	Software Packages-Chem/Physics/Life Science	67	17.0	18.6	83.9
	Engg and Earth Science	54	13.7	15.0	98.9
	Economics Software	4	1.0	1.1	100.0
	Total	361	91.9	100.0	
Missing	None	32	8.1		
Total		393	100.0		

The usage of software packages used by the schools of chemistry and school of life sciences are form the 60.1% and other software packages less than 20%.

Table 5: Year of Register

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2003	108	27.5	27.5	27.5
	2004	64	16.3	16.3	43.8

	2005	37	9.4	9.4	53.2
	2006	62	15.8	15.8	69.0
	2007	29	7.4	7.4	76.3
	2008	25	6.4	6.4	82.7
	2009	37	9.4	9.4	92.1
	2011	31	7.9	7.9	100.0
	Total	393	100.0	100.0	

Table 6: Use of Linux Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Linux	288	73.3	100.0	100.0
Missing	None	105	26.7		
Total		393	100.0		

Table 7: Use of AIX Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AIX	176	44.8	100.0	100.0
Missing	None	217	55.2		
Total		393	100.0		

Table 8: Purchase Time from Scientific Computing Centers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Purchase Time from Scientific Computing Centers	82	20.9	100.0	100.0
Missing	None	311	79.1		

Total	393	100.0		

From the above tables the registrations of user are reducing trend, it may be because of the awareness of HPC facility uses and advantages, it needs to conduct the workshops/training program about the HPC facility and its importance. The users are having the Linux and AIX platform operating system. The 20% users are still purchasing the system time from the outside the center. It indicating to the HPC facilities needs to upgrade its facility to attract the users.

Table 9: Need of Continuous Resources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Need of Continuous Resources	263	66.9	100.0	100.0
Missing	None	130	33.1		
Total		393	100.0		

Table 10: Resources on Demand

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Resources on Demand	64	16.3	100.0	100.0
Missing	None	329	83.7		
Total		393	100.0		

Table 11: Technical Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Technical Support	130	33.1	100.0	100.0
Missing	None	263	66.9		
Total		393	100.0		

Table 12: Application Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Application Support	253	64.4	100.0	100.0
Missing	None	140	35.6		
Total		393	100.0		

From the above frequency tables shows that, the 2/3rd of the users are in the need of continue resources require the 24x7 availability and 16% of the users requires on resources on demand availability. The 1/3rd of the users badly needs the technical support and 2/3rd needs the application support. The above findings, if there are properly address through e-CRM strategies it expected that the impact rating will enhance.

Table 13: Computational Projects Planning and Implementation Support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Computational Projects Planning and Implementation Support	121	30.8	100.0	100.0
Missing	None	272	69.2		
Total		393	100.0		

Table 14: Importance of Security of Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Security of Data Important	195	49.6	100.0	100.0
Missing	None	198	50.4		
Total		393	100.0		

Table 15: Unreliability of the System (Crashes)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Unreliability of the System(Crashes)	125	31.8	100.0	100.0
Missing	None	268	68.2		
Total		393	100.0		

Table 16: Long queuing time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Long queuing time	109	27.7	100.0	100.0
Missing	None	284	72.3		
Total		393	100.0		

Table 17: Substandard or missing technical support

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Substandard or missing technical support	98	24.9	100.0	100.0
Missing	None	295	75.1		
Total		393	100.0		

From the tables it shows that, the only 30% are provided with project planning and implementation support. It needs to improve by the HPC facility management. The 50% of the users are provided the security to the data. This also needs to address to improve. There are a 1/3rd of the users experiencing the system crashing. The 25% of the users are feeling that the technical support is not adequate. The 27% of the users are experiencing the jobs having the long queue. Some important, which are not availability of software requires.

Table 18: Long Support response time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Long Support response time	111	28.2	100.0	100.0
Missing	None	282	71.8		
Total		393	100.0		

Table 19: Too much time spent on Support issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Too much time spent on Support issues	103	26.2	100.0	100.0
Missing	None	290	73.8		
Total		393	100.0		

Table 20: Supercomputing Resource

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Additional RAM	78	19.8	21.8	21.8
	Additional Disk Space	44	11.2	12.3	34.2
	More Time allocation	40	10.2	11.2	45.4
	Block Time	25	6.4	7.0	52.4
	Reservation of Resources	94	23.9	26.3	78.7
	Better Network Connectivity	24	6.1	6.7	85.4
	Updated software	52	13.2	14.6	100.0
	Total	357	90.8	100.0	
Missing	None	36	9.2		
Total		393	100.0		

Table 21: Frequency of Job Submission

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	193	49.1	49.1	49.1
	Weekly	200	50.9	50.9	100.0
	Total	393	100.0	100.0	

Table 22: Use of HPC

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	183	46.6	46.6	46.6
	Weekly	174	44.3	44.3	90.8
	Monthly	30	7.6	7.6	98.5
	Rarely	6	1.5	1.5	100.0
	Total	393	100.0	100.0	

Table 23: Job Submission Process

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Excellent	93	23.7	23.7	23.7
	Satisfactory	195	49.6	49.6	73.3
	Moderate	69	17.6	17.6	90.8
	Complex	36	9.2	9.2	100.0
	Total	393	100.0	100.0	

From the above frequency tables it indicates that the users not getting immediate response in and in the support related issues the 50% of the users are satisfied around 24% are excellent. The users responded for increase in reservation of resources, additional RAM, additional Disk space and update the software. The job submission process should make elegant to enhance user capture and comfort is to executed, and increases percent to the excellent.

Table 24: Nature of the Job

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Parallelizable	158	40.2	40.2	40.2
	Serial	13	3.3	3.3	43.5
	Both	222	56.5	56.5	100.0
	Total	393	100.0	100.0	

Table 25: Security of Job

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	181	46.1	46.1	46.1
	Excellent	212	53.9	53.9	100.0
	Total	393	100.0	100.0	

Table 26: Security of the Data

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Good	219	55.7	55.7	55.7
	Excellent	174	44.3	44.3	100.0
	Total	393	100.0	100.0	

The above frequency tables show that the job of serial type is less than 5%. It means that the purpose of HPC facility is met. The purpose of High Performance computing facilities are to use for high end number crunching and parallel jobs. The 50% user are requires the security for job and data.

5.3 Qualitative Analysis:

Responses of the users input the categorical items of questionnaire like designation, organization have been considered for understanding the association characters for example the null hypothesis designation as independent of the organization of user against the designation and organization are dependent among the responders.

H0 – Attributes are independent.

H1 – Attributes are dependent

A chi-square computing analysis has been employed for investigating on control of give the two chances to the responder, absent of the data is provided in the following table the sub sections provide some of the selected statistical significant pair of attributes and its inference.

Designation * Field of Research

Table 27: Designation vs Field of Research

			Field of Research							Total
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	
Designation	Research Scholar	Count	0	45	70	42	4	4	8	173
		Expected Count	14.1	40.5	56.3	47.5	9.2	1.8	3.5	173.0
	Faculty	Count	22	37	40	48	12	0	0	159
		Expected Count	12.9	37.2	51.8	43.7	8.5	1.6	3.2	159.0
	Student	Count	10	10	18	18	5	0	0	61
		Expected Count	5.0	14.3	19.9	16.8	3.3	.6	1.2	61.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	55.240[a]	12	.000
Likelihood Ratio	72.136	12	.000
Linear-by-Linear Association	2.086	1	.149
N of Valid Cases	393		

a. 8 cells (38.1%) have expected count less than 5. The minimum expected count is .62.

The above Table-29 exhibits highly statistically significant dependency (p-value =0.000) between the field of research and designation indicating the rejection of null hypothesis i.e. field of research and designation are associated.

H0 – field of research and designation are independent.

H1 – field of research and designation are dependent

From the Table-29 it is clearly can be notice that the School of Mathematics and Statistics research scholars not using and mathematics faculty are more others are same as expected.

The chi-square test indicates that highly statistically significant. Hence it is concluded that field of research and designation are associates.

The effective e-CRM for satisfactory motivate and entrust in access the disciplines and designations.

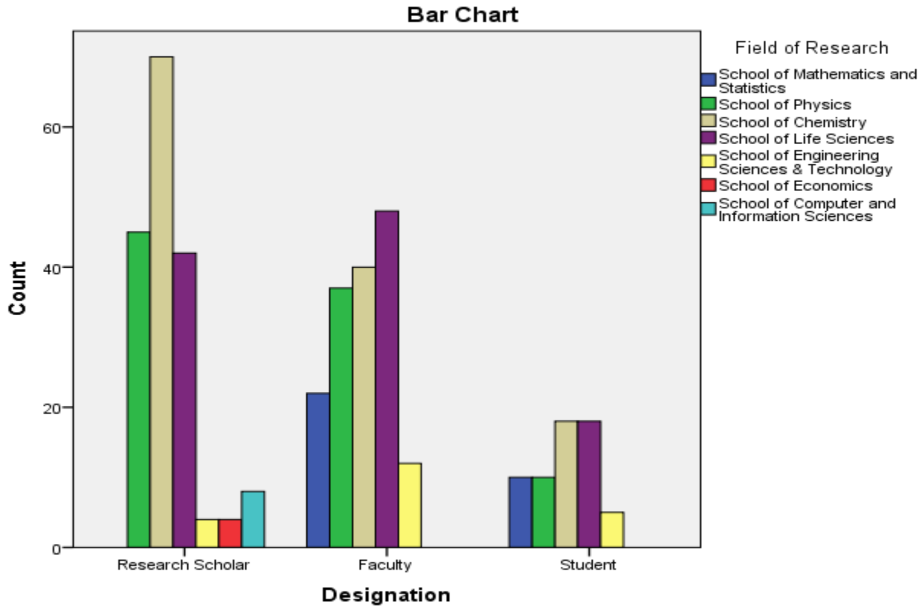


Figure 1 Designation vs Field of Research

User's proportion is significant in the designation and field of research. The Schools of Chemistry and School of Computer Information Sciences research scholars are using more. While School of Mathematics and Statistics and School of Engineering Sciences and Technology research scholars are using less than expected. Even the Mathematics faculty is turnout to be more than expected.

Designation * Group of Software Packages Used-2

Table 28: Designation vs Group of Software Packages Used-2

	Group of Software Packages Used				
	Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/ Life Science	Engg and Earth Science	Economics Software	Total

Designation	Research Scholar	Count	112	53	4	4	173
		Expected Count	113.1	32.1	25.9	1.9	173.0
	Faculty	Count	88	14	35	0	137
		Expected Count	89.6	25.4	20.5	1.5	137.0
	Student	Count	36	0	15	0	51
		Expected Count	33.3	9.5	7.6	.6	51.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	68.679[a]	6	.000
Likelihood Ratio	85.361	6	.000
Linear-by-Linear Association	3.617	1	.057
N of Valid Cases	361		

5.1 3 cells (25.0%) have expected count less than 5. The minimum expected count is .57.

The above Table-30 exhibits highly statistically significant dependency (p-value =0.000) between the Group of Software Packages used-2 and designation indicating the rejection of null hypothesis i.e. Group of Software Packages used-2 and designation are associated.

H0 – Group of Software Packages used-2 and designation is independent.

H1 – Group of Software Packages used-2 and designation are dependent

From the above Table-30 it is found that the Research Scholars of School of Chemistry, Physics and Life Sciences are using Packages more than the expected.

The Designation and the Group of Software Packages used-2 is significant. The faculty is using the above group of software packages as expected. The research scholars are using the other software packages as expected.

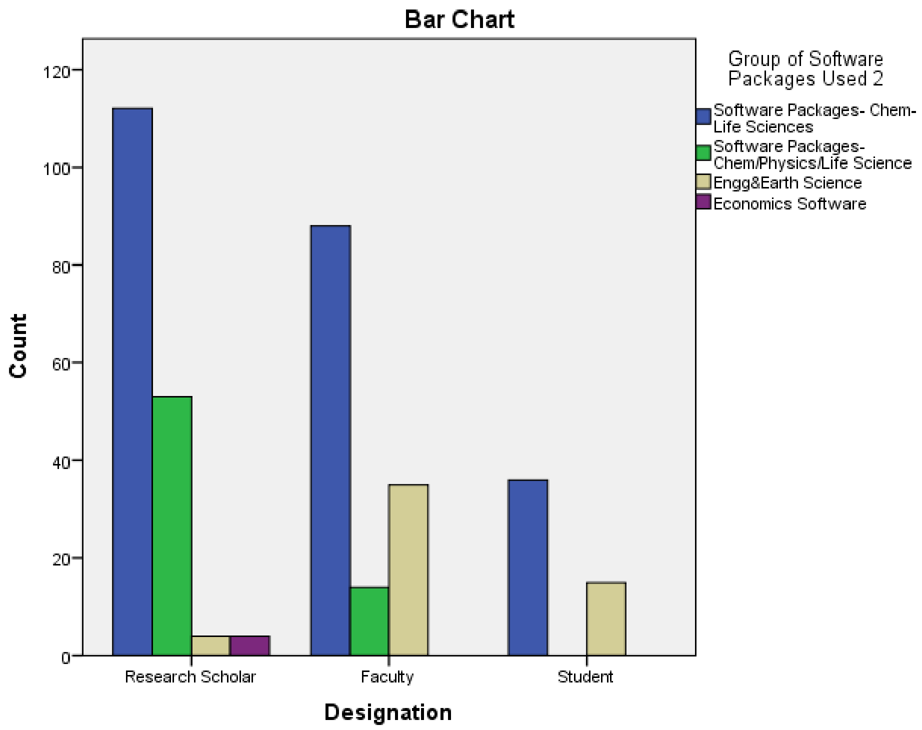


Figure 2 Designation vs Group of Software Packages Used-2

Designation * Year of Register

Table 29: Designation vs Year of Register

			Year of Register								
			2003	2004	2005	2006	2007	2008	2009	2011	Total
Designation	Research Scholar	Count	2	49	0	59	0	4	32	27	173
		Expected Count	47.5	28.2	16.3	27.3	12.8	11.0	16.3	13.6	173.0
	Faculty	Count	74	15	23	3	14	21	5	4	159
		Expected Count	43.7	25.9	15.0	25.1	11.7	10.1	15.0	12.5	159.0
	Student	Count	32	0	14	0	15	0	0	0	61
		Expected Count	16.8	9.9	5.7	9.6	4.5	3.9	5.7	4.8	61.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	315.759[a]	14	.000
Likelihood Ratio	391.076	14	.000
Linear-by-Linear Association	58.182	1	.000
N of Valid Cases	393		

3 cells (12.5%) have expected count less than 5. The minimum expected count is 3.88.

The above Table-31 exhibits statistically significant dependency (p-value =0.000) between the year of register and designation indicating the rejection of null hypothesis i.e. year of register and designation are associated.

H0 – year of register and designation are independent.

H1 – year of register and designation are dependent

The Designation and the year of register are significant. The faculty are register much more than expected in the 2003 and research scholar are registered more than expected in the years 2004,2006,2009 and 2011.

The research scholars are using relatively more than the expected over the years, while faculty is showing declined than the expected. This may be because of the researchers are more skilled, attitude, IQ levels. The researchers are capable of acquiring the apt skills whereas faculty is not able to coupe-up with the changes in the technology growth. This emphasizes, a tailor made customized relational interfaces are essential.

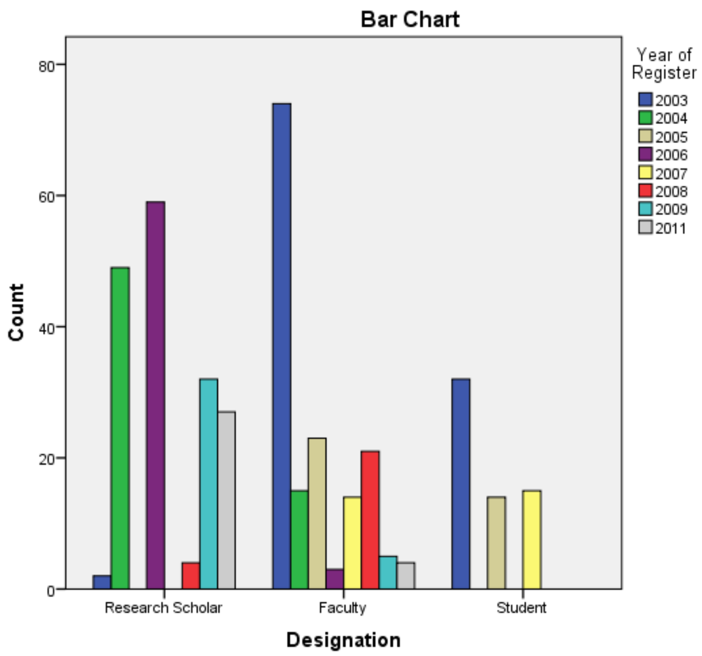


Figure 3 Designation vs Year of Register

Designation * Security of the Data

Table 30: Designation vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Designation	Research Scholar	Count	98	75	173
		Expected Count	96.4	76.6	173.0
	Faculty	Count	96	63	159
		Expected Count	88.6	70.4	159.0
	Student	Count	25	36	61
		Expected Count	34.0	27.0	61.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.827[a]	2	.033
Likelihood Ratio	6.796	2	.033
Linear-by-Linear Association	2.243	1	.134

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 27.01.

The above cross Table-32 exhibits statistically significant dependency (p-value =0.033) between the Security of the Data and designation.

H0 – Security of the Data and designation are independent.

H1 – Security of the Data and designation are dependent

From the above Table-32, the faculty rated the security of the data consistent and reliable, whereas the research scholar and students are rated excellent.

The Designation and the security of the data are significant. The faculty is using the security of the data more than expected.

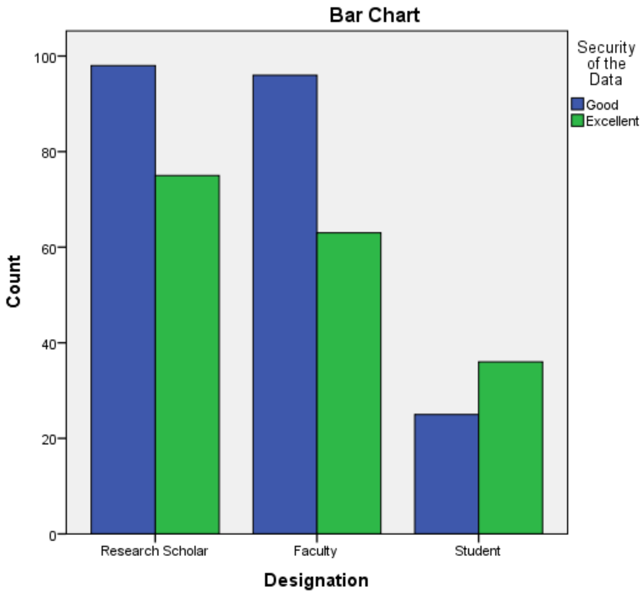


Figure 4 Designation vs Security of the Data

Designation * Supercomputing Resource-1

Table 31: Designation vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Designation	Research Scholar	Count	53	6	18	8	30	7	17	139
		Expected Count	30.4	17.1	15.6	9.7	36.6	9.3	20.2	139.0
	Faculty	Count	17	29	16	13	45	11	26	157
		Expected Count	34.3	19.4	17.6	11.0	41.3	10.6	22.9	157.0
	Student	Count	8	9	6	4	19	6	9	61
		Expected Count	13.3	7.5	6.8	4.3	16.1	4.1	8.9	61.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.863[a]	12	.000
Likelihood Ratio	46.898	12	.000
Linear-by-Linear Association	10.078	1	.002
N of Valid Cases	357		

a. 2 cells (9.5%) have expected count less than 5. The minimum expected count is 4.10.

The above cross Table-33 exhibits statistically significant dependency (p-value =0.000) between the Supercomputing Resource-1 and designation indicating the rejection of null hypothesis i.e. Supercomputing Resource-1 and designation are associated.

H0 – Supercomputing Resource-1 and designation are independent.

H1 – Supercomputing Resource-1 and designation are dependent.

The Designation and the supercomputing resource-1 are more significant.

From the above Table-33 research scholars are requesting for additional RAM and more time allocation for their jobs. The faculty is want of more disk space, reservation of resources and better network facility. The research scholars requires the more RAM and CPU time more than expected

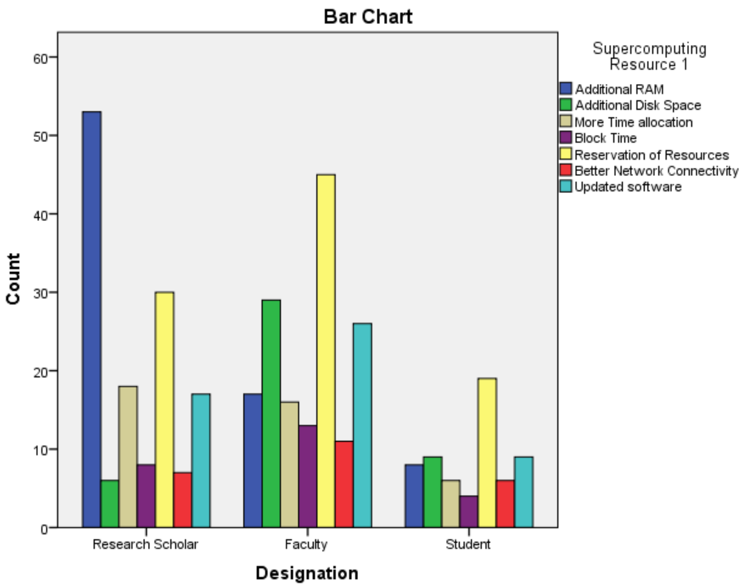


Figure 5 Designation vs Supercomputing Resource-1

Organization * Field of Research

Table 32: Organization vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
		Count	30	75	113	98	11	0	8	335

Organization	UNIVERSITY OF HYDERABAD	Expected Count	27.3	78.4	109.1	92.1	17.9	3.4	6.8	335.0
	Other	Count	2	17	15	10	10	4	0	58
		Expected Count	4.7	13.6	18.9	15.9	3.1	.6	1.2	58.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	48.903[a]	6	.000
Likelihood Ratio	37.728	6	.000
Linear-by-Linear Association	13.701	1	.000
N of Valid Cases	393		

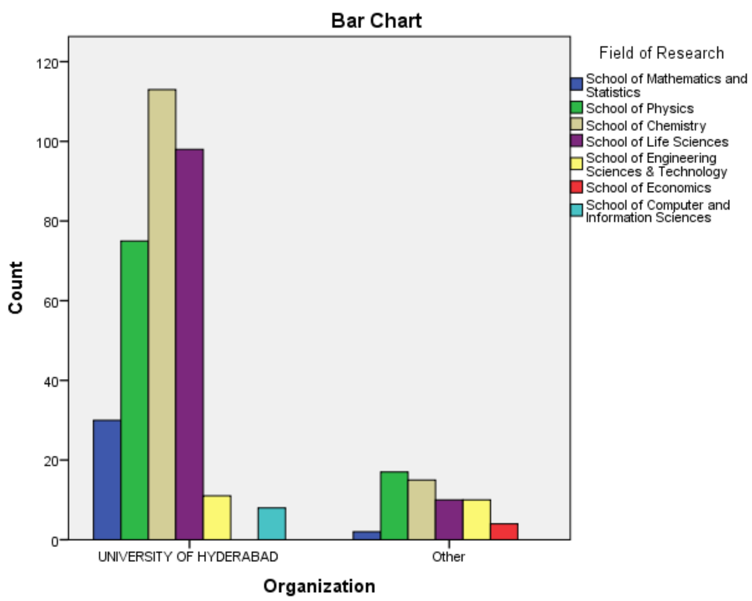


Figure 6 Organization vs Field of Research

The above cross Table-34 exhibits statistically significant dependency (p-value =0.000) between the Organization and Field of Research indicating the rejection of null hypothesis i.e. Organization and Field of Research are associated.

H0 – Organization and Field of Research are independent.

H1 – Organization and Field of Research are dependent

The Organization and Field of Research are more significant.

From the above Table-34 Research scholars of School of Life Sciences, School of Chemistry, School of Physics, are School of Mathematics and Statistics are using more University of Hyderabad High Performance Computing Facility.

Organization * Year of Register

Table 33: Organization vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Organization	UNIVERSITY OF HYDERABAD	Count	88	59	32	50	23	18	35	30	335
		Expected Count	92.1	54.6	31.5	52.8	24.7	21.3	31.5	26.4	335.0
	Other	Count	20	5	5	12	6	7	2	1	58
		Expected Count	15.9	9.4	5.5	9.2	4.3	3.7	5.5	4.6	58.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.901[a]	7	.037
Likelihood Ratio	16.498	7	.021
Linear-by-Linear Association	1.675	1	.196
N of Valid Cases	393		

a. 3 cells (18.8%) have expected count less than 5. The minimum expected count is 3.69.

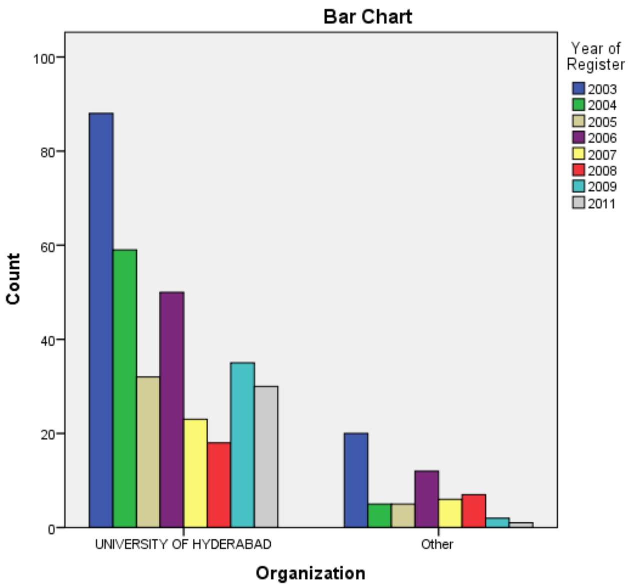


Figure 7 Organization vs Year of Register

The above cross Table-35 exhibits statistically significant dependency (p-value =0.037) between the Year of register and Organization.

H0 – Organization and Year of Register are independent.

H1 – Organization and Year of Register are dependent.

The Organization and Year of Register are significant.

From the above Table-35 outside users are using less in number. It needs to increase/develop the skills network connectivity support, virtual guidance to support remotely by email/online. The Organization and Year of Register are significant.

Organization * Frequency of Job Submission

Table 34: Organization vs Frequency of Job Submission

			Frequency of Job Submission		Total
			Daily	Weekly	
Organization	UNIVERSITY OF HYDERABAD	Count	156	179	335
		Expected Count	164.5	170.5	335.0
	Other	Count	37	21	58
		Expected Count	28.5	29.5	58.0
Total		Count	193	200	393
		Expected Count	193.0	200.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.870[a]	1	.015		
Continuity Correction[b]	5.201	1	.023		
Likelihood Ratio	5.927	1	.015		
Fisher's Exact Test				.016	.011
Linear-by-Linear Association	5.855	1	.016		

The above cross Table-36 exhibits statistically significant dependency (p-value =0.015) between the Organization and Frequency of job submission.

H0 – Organization and Frequency of job submission are independent.

H1 – Organization and Frequency of job submission are dependent

The Organization and Frequency of job submission are significant.

From the above Table-36 the Frequency of job submission is more by the weekly users of University of Hyderabad High Performance Computing Facility.

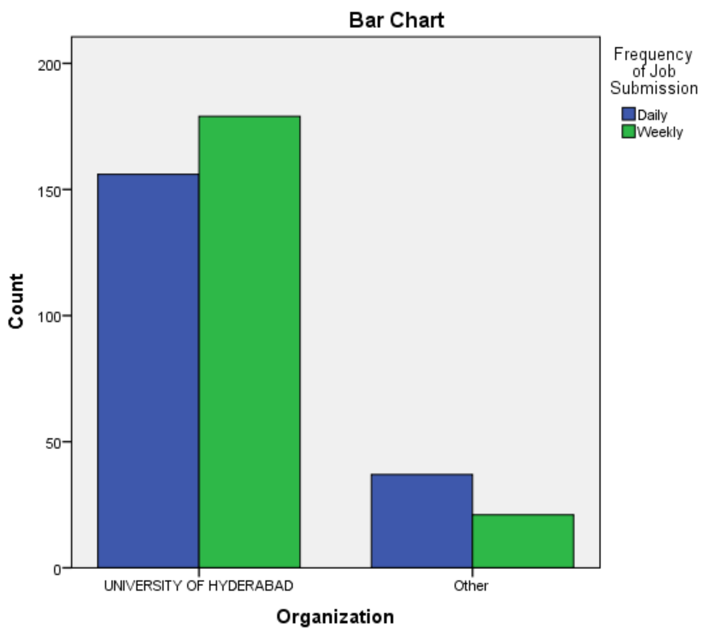


Figure 8 Organization vs Frequency of Job Submission

Organization * Use of HPC

Table 35: Organization vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Organization	UNIVERSITY OF HYDERABAD	Count	146	156	28	5	335
		Expected Count	156.0	148.3	25.6	5.1	335.0
	Other	Count	37	18	2	1	58
		Expected Count	27.0	25.7	4.4	.9	58.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.610[a]	3	.035
Likelihood Ratio	8.839	3	.032
Linear-by-Linear Association	6.321	1	.012
N of Valid Cases	393		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is .89.

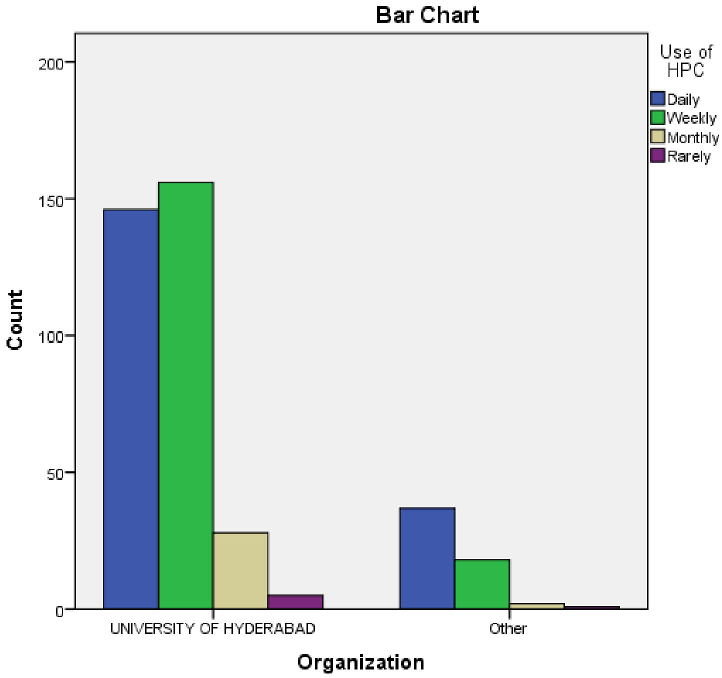


Figure 9 Organization vs Use of HPC

The above cross Table-37 exhibits statistically significant dependency (p-value =0.035) between the Organization and Use of HPC.

H0 – Organization and Use of HPC are independent.

H1 – Organization and Use of HPC are dependent

The Organization and Use of HPC are significant.

From the above Table-37 the Use of HPC is more than expected by the weekly users of University of Hyderabad High Performance Computing Facility.

Organization * Application Parallel or Serial

Table 36: Organization vs Application Parallel or Serial

			Application Parallel or Serial		Total
			Parallel	Serial	
Organization	UNIVERSITY OF HYDERABAD	Count	192	143	335
		Expected Count	199.5	135.5	335.0
	Other	Count	42	16	58
		Expected Count	34.5	23.5	58.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.680[a]	1	.031		
Continuity Correction[b]	4.074	1	.044		
Likelihood Ratio	4.873	1	.027		
Fisher's Exact Test				.031	.020
Linear-by-Linear Association	4.668	1	.031		
N of Valid Cases	393				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.47.
b. Computed only for a 2x2 table

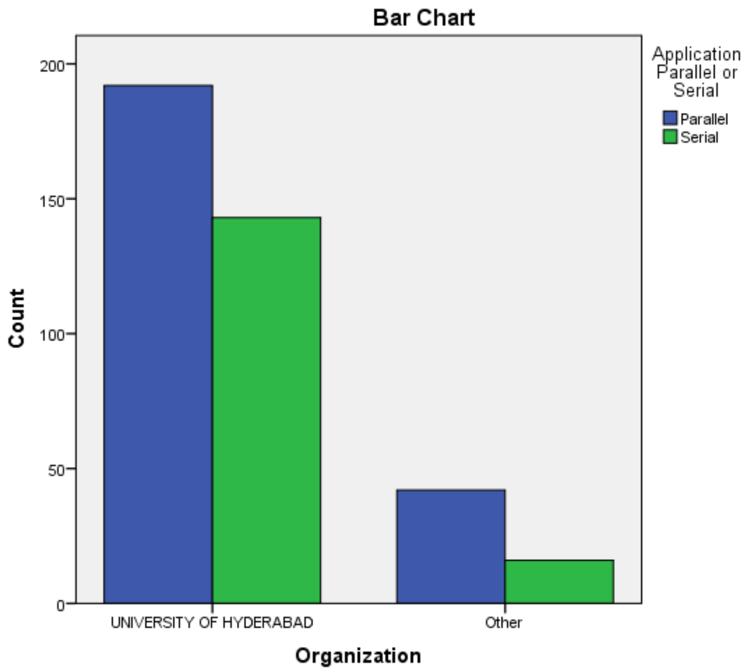


Figure 10 Organization vs Application Parallel or Serial

The above cross Table-38 exhibits statistically significant dependency (p-value =0.031) between the Organization and Application Parallel or Serial.

H0 – Organization and Application Parallel or Serial are independent.

H1 – Organization and Application Parallel or Serial are dependent

The Organization and Application Parallel or Serial are significant.

From the above Table-38 the Application Serial users are using more than expected the facility of University of Hyderabad High Performance Computing Facility.

University of Hyderabad users are using more serial jobs than the remote login users. The real utilization of the HPC is can be achieved by controlling the serial jobs. We can derive the objective of the HPC facility.

Organization * Supercomputing Resource-1

Table 37: Organization vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Organization	UNIVERSITY OF HYDERABAD	Count	73	38	35	23	72	16	46	303
		Expected Count	66.2	37.3	33.9	21.2	79.8	20.4	44.1	303.0
	Other	Count	5	6	5	2	22	8	6	54
		Expected Count	11.8	6.7	6.1	3.8	14.2	3.6	7.9	54.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	17.631[a]	6	.007
Likelihood Ratio	17.055	6	.009
Linear-by-Linear Association	5.632	1	.018
N of Valid Cases	357		

b. 2 cells (14.3%) have expected count less than 5. The minimum expected count is 3.63

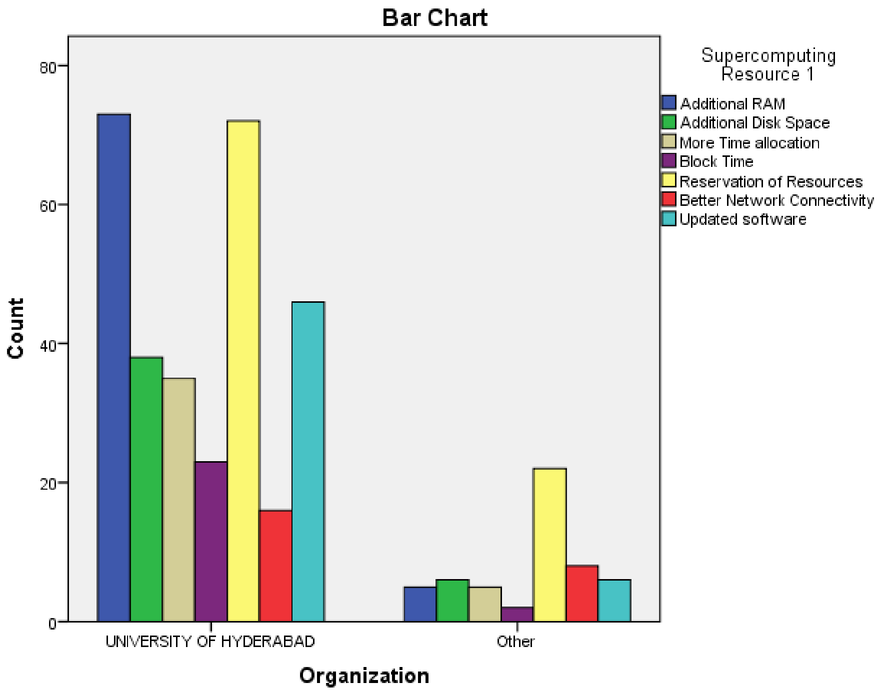


Figure 11 Organization vs Supercomputing Resource-1

The above cross Table-39 exhibits statistically significant dependency (p-value =0.007) between the Organization and Supercomputing Resource-1 and Organization.

H0 – Organization and Supercomputing Resource-1 are independent.

H1 – Organization and Supercomputing Resource-1 are dependent

The Organization and Supercomputing Resource-1 are significant.

From the above Table-39 the Users are requesting the more RAM, Disk space and updated software at University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Field of Research

Table 38: Frequency of Job Submission vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Frequency of Job Submission	Daily	Count	15	60	66	44	6	0	2	193
		Expected Count	15.7	45.2	62.9	53.0	10.3	2.0	3.9	193.0
	Weekly	Count	17	32	62	64	15	4	6	200
		Expected Count	16.3	46.8	65.1	55.0	10.7	2.0	4.1	200.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.215[a]	6	.001
Likelihood Ratio	24.132	6	.000
Linear-by-Linear Association	13.592	1	.000
N of Valid Cases	393		

a. 4 cells (28.6%) have expected count less than 5. The minimum expected count is 1.96.

The above cross Table-40 exhibits statistically significant dependency (p-value =0.001) between the Frequency of Job Submission and Field of Research.

H0 – Frequency of Job Submission and Field of Research are independent.

H1 – Frequency of Job Submission and Field of Research are dependent

The Frequency of Job Submission and Field of Research are significant.

From the above Table-40 the Frequency of Job Submission by the researchers of school of chemistry is high of daily while the faculty of life science is more for weekly job submission at University of Hyderabad High Performance Computing Facility.

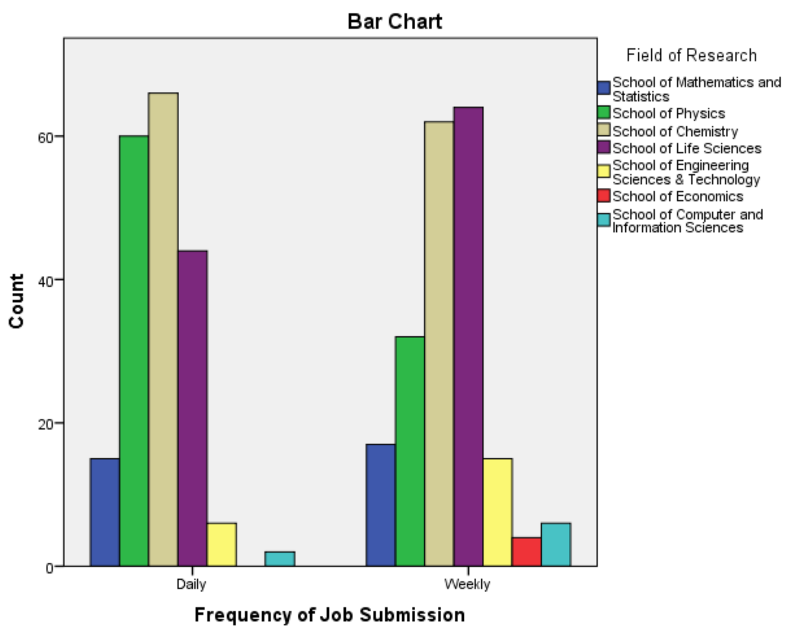


Figure 12 Frequency of Job Submission vs Field of Research

Frequency of Job Submission * Group of Software Packages Used-2

Table 39: Frequency of Job Submission vs Group of Software Packages Used-2

			Group of Software Packages Used-2				
			Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Economics Software	Total
Frequency of Job Submission	Daily	Count	110	41	27	0	178
		Expected Count	116.4	33.0	26.6	2.0	178.0
	Weekly	Count	126	26	27	4	183
		Expected Count	119.6	34.0	27.4	2.0	183.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.375[a]	3	.039
Likelihood Ratio	9.948	3	.019
Linear-by-Linear Association	.140	1	.708
N of Valid Cases	361		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 1.97.

The above cross Table-41 exhibits statistically significant dependency (p-value =0.039) between the Frequency of Job Submission and Group of Software Packages used-2.

The Frequency of Job Submission and Group of Software Packages used-2 are significant.

H0 – Frequency of Job Submission and Group of Software Packages used-2 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-2 are dependent

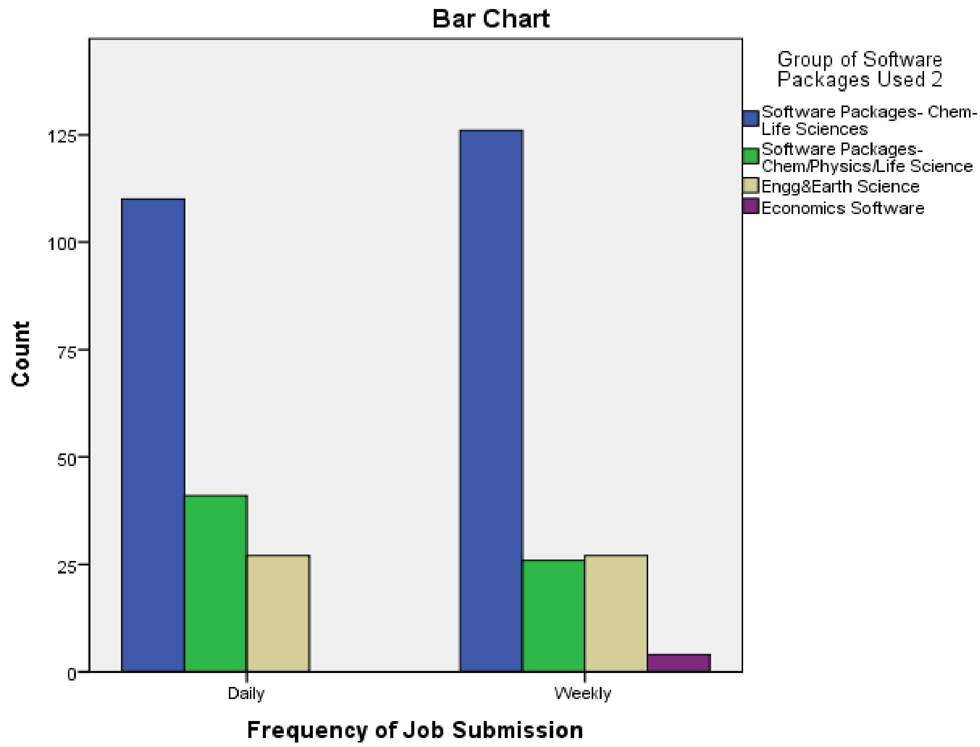


Figure 13 Frequency of Job Submission vs Group of Software Packages Used-2

Frequency of Job Submission * Group of Software Packages Used-3

Table 40: Frequency of Job Submission vs Group of Software Packages Used-3

			Group of Software Packages Used-3			
			Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Software Packages-Chem/Physics/Enng Science	Total
Frequency of Job Submission	Daily	Count	110	4	58	172
		Expected Count	120.8	5.1	46.1	172.0
	Weekly	Count	126	6	32	164
		Expected Count	115.2	4.9	43.9	164.0
Total		Count	236	10	90	336
		Expected Count	236.0	10.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.810[a]	2	.012
Likelihood Ratio	8.917	2	.012
Linear-by-Linear Association	8.174	1	.004
N of Valid Cases	336		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 4.88.

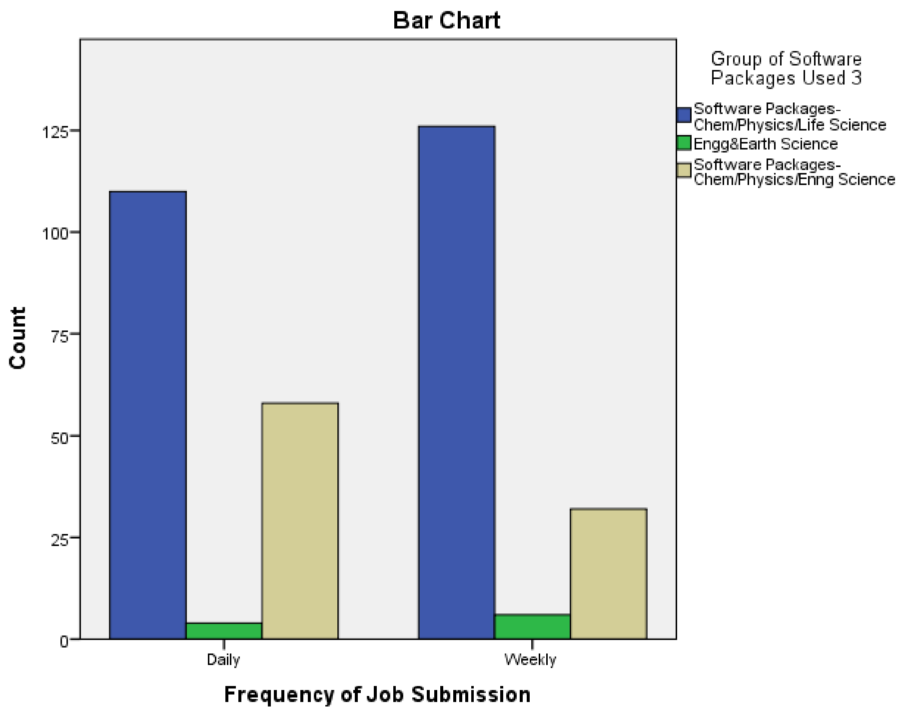


Figure 14 Frequency of Job Submission vs Group of Software Packages Used-3

The above cross Table-42 exhibits statistically significant dependency (p-value =0.012) between the Frequency of Job Submission and Group of Software Packages used-3.

H0 – Frequency of Job Submission and Group of Software Packages used-3 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-3 are dependent

The Frequency of Job Submission and Group of Software Packages used-3 are significant.

From the above Table-42 the Frequency of Job Submission by the faculty are using the using Group of Software Packages used-3 is more for weekly job submission at users University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Group of Software Packages Used-4

Table 41: Frequency of Job Submission vs Group of Software Packages Used-4

			Group of Software Packages Used-4				
			Economics Software	Software Packages-Chem/Physics/Enng Science	Software Packages - Life science	Software Packages -Physics Chemistry	Total
Frequency of Job Submission	Daily	Count	4	66	44	58	172
		Expected Count	5.1	65.5	55.3	46.1	172.0
	Weekly	Count	6	62	64	32	164
		Expected Count	4.9	62.5	52.7	43.9	164.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	11.556[a]	3	.009
Likelihood Ratio	11.682	3	.009
Linear-by-Linear Association	3.016	1	.082
N of Valid Cases	336		

a. 1 cells (12.5%) have expected count less than 5. The minimum expected count is 4.88.

The above cross Table-43 exhibits statistically significant dependency (p-value =0.009) between the Frequency of Job Submission and Group of Software Packages used-4.

H0 – Frequency of Job Submission and Group of Software Packages used-4 are independent.

H1 – Frequency of Job Submission and Group of Software Packages used-4 are dependent

The Frequency of Job Submission and Group of Software Packages used-4 are significant.

From the above Table-43 the Frequency of Job Submission by the faculty are using the using Group of Software Packages used-4 is more for weekly job submission at users University of Hyderabad High Performance Computing Facility.

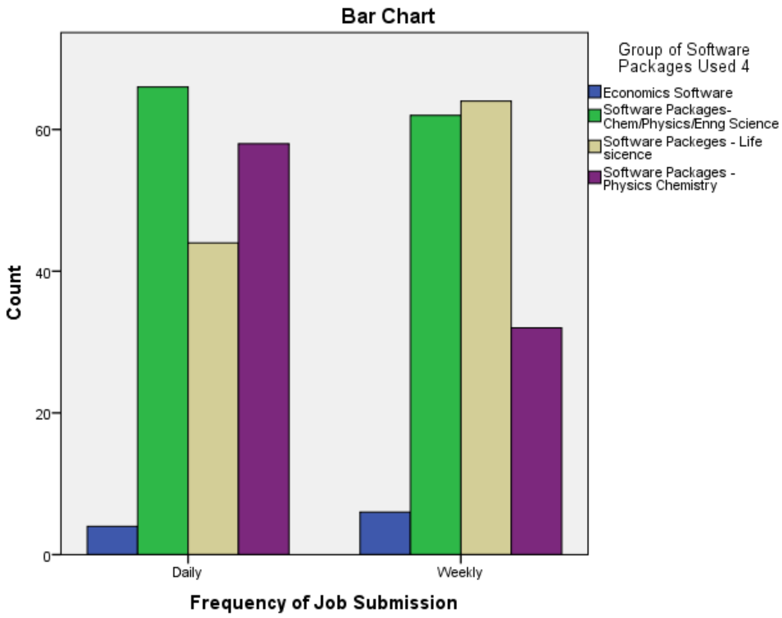


Figure 15 Frequency of Job Submission vs Group of Software Packages Used-4

Frequency of Job Submission * Year of Register

Table 42: Frequency of Job Submission vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Frequency of Job Submission	Daily	Count	37	41	23	33	20	15	16	8	193
		Expected Count	53.0	31.4	18.2	30.4	14.2	12.3	18.2	15.2	193.0
	Weekly	Count	71	23	14	29	9	10	21	23	200
		Expected Count	55.0	32.6	18.8	31.6	14.8	12.7	18.8	15.8	200.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)

Pearson Chi-Square	31.205[a]	7	.000
Likelihood Ratio	31.899	7	.000
Linear-by-Linear Association	.086	1	.769
N of Valid Cases	393		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.28.

The above Table-44 exhibits statistically significant dependency (p-value =0.000) between the Frequency of Job Submission and Year of Register.

H0 – Frequency of Job Submission and Year of Register are independent.

H1 – Frequency of Job Submission and Year of Register are dependent

The Frequency of Job Submission and Year of Register are significant.

The latent registered utility of the infrastructure of HPC is getting dropped than the excepted.

Rapid awareness, effective utilization, training programmes through e-CRM among the recently registered users. Through which the latency in full utilization can be minimize.

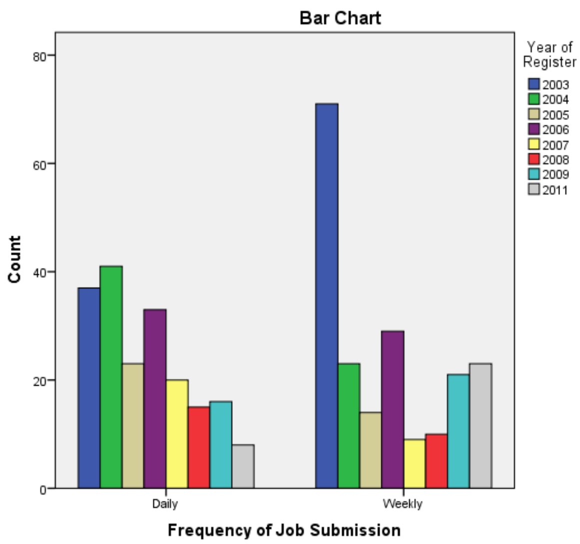


Figure 16 Frequency of Job Submission vs Group of Software Packages Used-4

Frequency of Job Submission * Use of HPC

Table 43: Frequency of Job Submission vs Use of HPC

	Use of HPC	Total

			Daily	Weekly	Monthly	Rarely	
Frequency of Job Submission	Daily	Count	154	22	11	6	193
		Expected Count	89.9	85.5	14.7	2.9	193.0
	Weekly	Count	29	152	19	0	200
		Expected Count	93.1	88.5	15.3	3.1	200.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	190.578[a]	3	.000
Likelihood Ratio	213.186	3	.000
Linear-by-Linear Association	81.653	1	.000
N of Valid Cases	393		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 2.95.

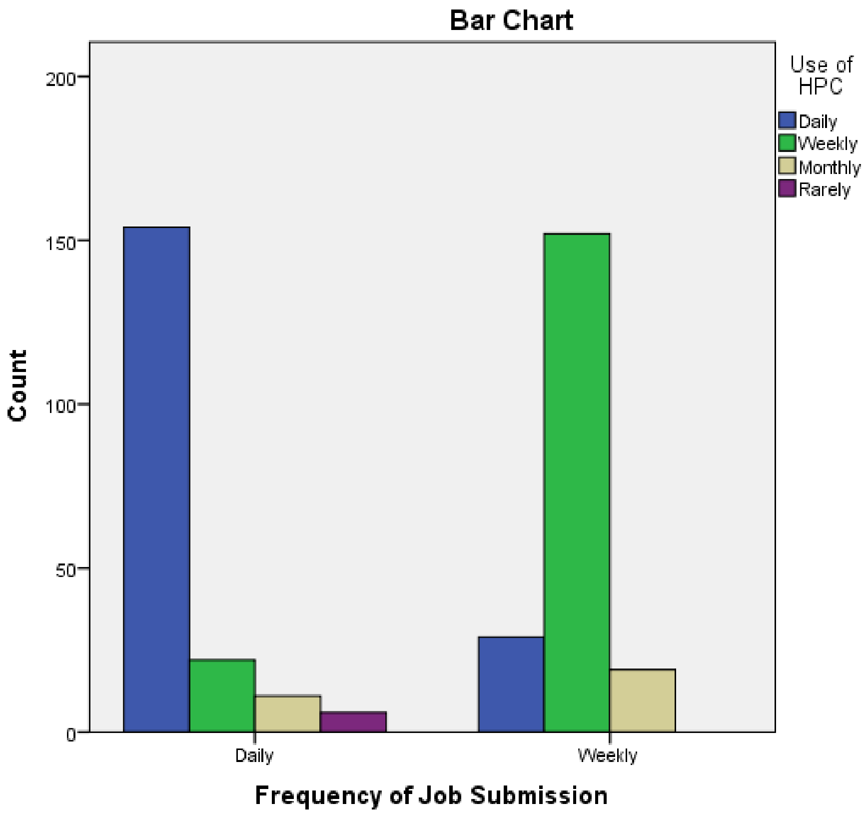


Figure 17 Frequency of Job Submission vs Use of HPC

The above cross Table-45 exhibits statistically significant dependency (p-value =0.000) between the Frequency of Job Submission and Use of HPC.

H0 – Frequency of Job Submission and Use of HPC are independent.

H1 – Frequency of Job Submission and Use of HPC are dependent

The Frequency of Job Submission and Use of HPC are significant.

From the above Table-45 the Researchers is more use of HPC daily and faculty using is using more on weekly at University of Hyderabad High Performance Computing Facility.

Frequency of Job Submission * Job Submission Process

Table 44: Frequency of Job Submission vs Job Submission Process

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Frequency of Job Submission	Daily	Count	35	101	34	23	193
		Expected Count	45.7	95.8	33.9	17.7	193.0
	Weekly	Count	58	94	35	13	200
		Expected Count	47.3	99.2	35.1	18.3	200.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.610[a]	3	.035
Likelihood Ratio	8.703	3	.034
Linear-by-Linear Association	6.105	1	.013
N of Valid Cases	393		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.68.

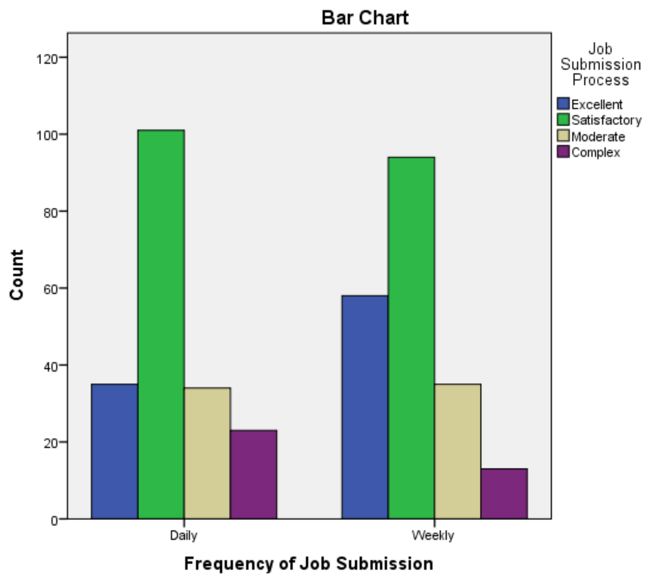


Figure 18 Frequency of Job Submission vs Job Submission Process

The above cross Table-46 exhibits statistically significant dependency (p-value =0.035) between the Frequency of Job Submission and Job submission process.

H0 – Frequency of Job Submission and Job submission process are independent.

H1 – Frequency of Job Submission and Job submission process are dependent.

The Frequency of Job Submission and Job submission process are significant.

The frequency of job submission is submitting the more complex than expected, henceforth the declining in the trend. The job submission process needs to be simplified.

Frequency of Job Submission * Application Parallel or Serial

Table 45: Frequency of Job Submission vs Application Parallel or Serial

			Application Parallel or Serial		
			Parallel	Serial	Total
Frequency of Job Submission	Daily	Count	101	92	193
		Expected Count	114.9	78.1	193.0
	Weekly	Count	133	67	200
		Expected Count	119.1	80.9	200.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.185[a]	1	.004		
Continuity Correction[b]	7.607	1	.006		
Likelihood Ratio	8.212	1	.004		
Fisher's Exact Test				.005	.003
Linear-by-Linear Association	8.164	1	.004		
N of Valid Cases	393				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 78.08.
b. Computed only for a 2x2 table

The above cross Table-47 exhibits statistically significant dependency (p-value =0.004) between the Frequency of Job Submission and Application Parallel or Serial.

H0 – Frequency of Job Submission and Application Parallel or Serial are independent.

H1 – Frequency of Job Submission and Application Parallel or Serial are dependent

The Frequency of Job Submission and Application Parallel or Serial is significant.

From the above Table-47 the Frequency of Job Submission is more by Parallel users in weekly and Serial by daily users at University of Hyderabad High Performance Computing Facility. The serial jobs needs to be reducing to meet the objective of the HPC.

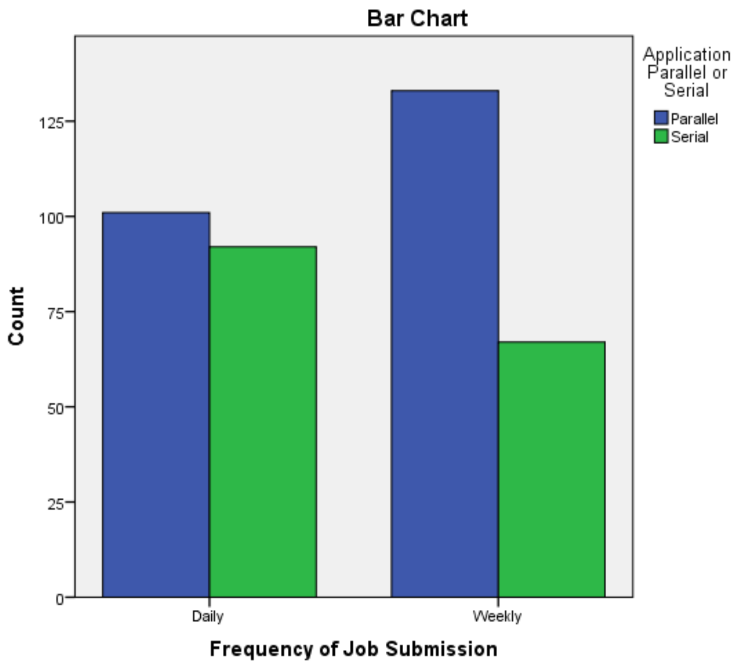


Figure 19 Frequency of Job Submission vs Application Parallel or Serial

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Use of HPC * Organization	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Field of Research	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Group of Software Packages Used 2	361	91.9%	32	8.1%	393	100.0%
Use of HPC * Group of Software Packages Used 3	336	85.5%	57	14.5%	393	100.0%
Use of HPC * Group of Software Packages Used 4	336	85.5%	57	14.5%	393	100.0%
Use of HPC * Year of Register	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Job Submission Process	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Nature of the Job	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Security of the Data	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Financial Support	393	100.0%	0	0.0%	393	100.0%
Use of HPC * HPC Rating	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Infrastructural Facility	393	100.0%	0	0.0%	393	100.0%
Use of HPC * Supercomputing Resource 1	357	90.8%	36	9.2%	393	100.0%
Use of HPC * Supercomputing Resource 2	269	68.4%	124	31.6%	393	100.0%
Use of HPC * Supercomputing Resource 3	115	29.3%	278	70.7%	393	100.0%
Use of HPC * Supercomputing Resource 4	51	13.0%	342	87.0%	393	100.0%

Use of HPC * Field of Research

Table 46: Use of HPC vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Use of HPC	Daily	Count	17	60	57	41	6	0	2	183
		Expected Count	14.9	42.8	59.6	50.3	9.8	1.9	3.7	183.0
	Weekly	Count	12	21	57	61	13	4	6	174
		Expected Count	14.2	40.7	56.7	47.8	9.3	1.8	3.5	174.0
	Monthly	Count	3	7	12	6	2	0	0	30
		Expected Count	2.4	7.0	9.8	8.2	1.6	.3	.6	30.0
	Rarely	Count	0	4	2	0	0	0	0	6
		Expected Count	.5	1.4	2.0	1.6	.3	.1	.1	6.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.334[a]	18	.001
Likelihood Ratio	46.487	18	.000
Linear-by-Linear Association	4.099	1	.043
N of Valid Cases	393		

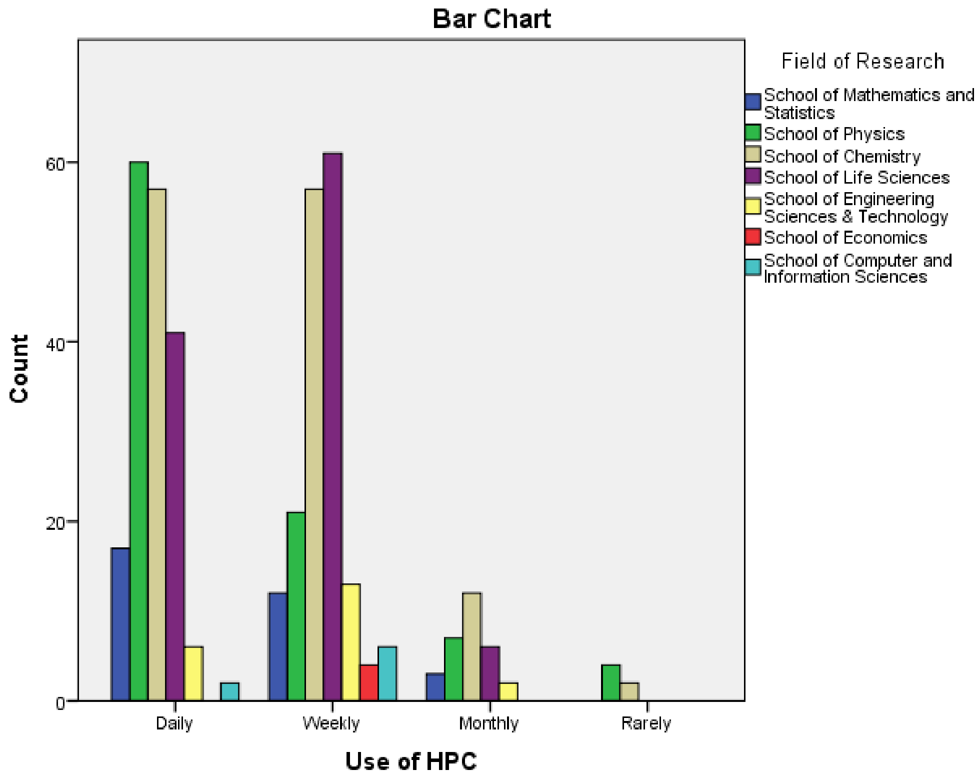


Figure 20 Use of HPC vs Field of Research

The above cross Table-48 exhibits statistically significant dependency (p-value =0.001) between the Use of HPC and Field of Research.

H0 – Use of HPC and Field of Research are independent.

H1 – Use of HPC and Field of Research are dependent

The Use of HPC and Field of Research are significant.

From the above Table-48 the School of physics is using HPC more in daily category at University of Hyderabad High Performance Computing Facility.

Use of HPC * Year of Register

Table 47: Use of HPC vs Year of Register

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	66.282[a]	21	.000
Likelihood Ratio	61.556	21	.000
Linear-by-Linear Association	7.804	1	.005
N of Valid Cases	393		

a. 15 cells (46.9%) have expected count less than 5. The minimum expected count is .38.

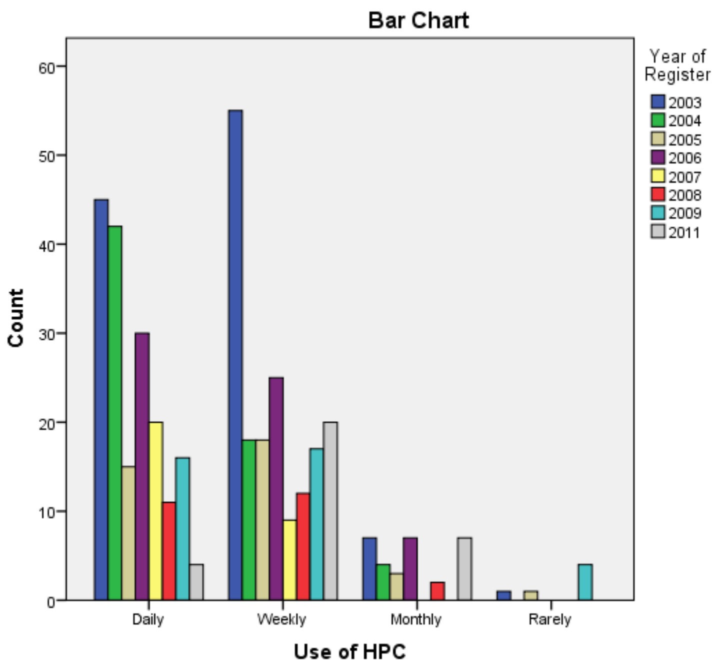


Figure 21 Use of HPC vs Year of Register

Use of HPC * Job Submission Process

Table 48: Use of HPC vs Year of Register

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Use of HPC	Daily	Count	40	87	40	16	183

		Expected Count	43.3	90.8	32.1	16.8	183.0
	Weekly	Count	37	96	23	18	174
		Expected Count	41.2	86.3	30.5	15.9	174.0
	Monthly	Count	16	6	6	2	30
		Expected Count	7.1	14.9	5.3	2.7	30.0
	Rarely	Count	0	6	0	0	6
		Expected Count	1.4	3.0	1.1	.5	6.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.873[a]	9	.001
Likelihood Ratio	29.824	9	.000
Linear-by-Linear Association	3.025	1	.082
N of Valid Cases	393		

a. 5 cells (31.3%) have expected count less than 5. The minimum expected count is .55.

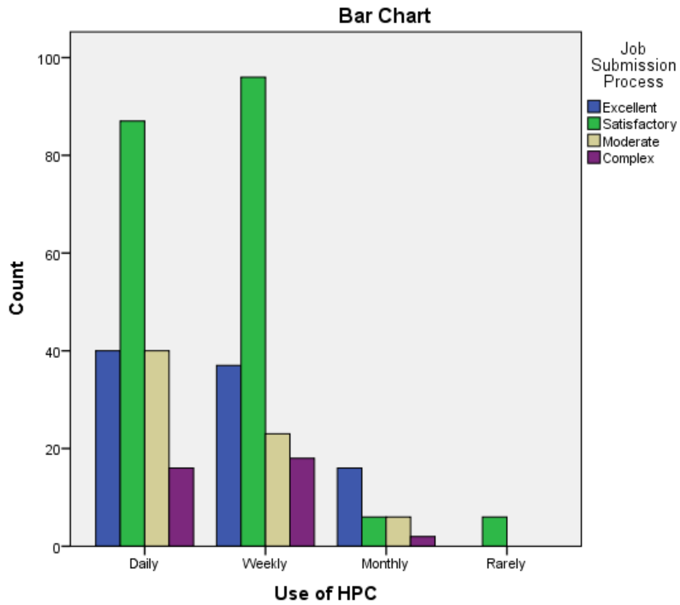


Figure 22 Use of HPC vs Year of Register

The above cross Table-50 exhibits statistically significant dependency (p-value =0.001) between the Use of HPC and Job submission Process.

H0 – Use of HPC and Job submission Process are independent.

H1 – Use of HPC and Job submission Process are dependent

The Use of HPC and Job submission Process are significant.

The daily users are well appreciated the job submission process, whereas others are expressed less satisfactory. Which indicates job submission process are highly technical need persistent efforts. A frame work embedded in e-CRM by simplifying in job submission process will enhance satisfaction levels.

Use of HPC * Nature of the Job

Table 49: Use of HPC vs Nature of the Job

			Nature of the Job			
			Parallelizable	Serial	Both	Total
Use of HPC	Daily	Count	77	5	101	183
		Expected Count	73.6	6.1	103.4	183.0
	Weekly	Count	79	4	91	174
		Expected Count	70.0	5.8	98.3	174.0
	Monthly	Count	2	0	28	30
		Expected Count	12.1	1.0	16.9	30.0
	Rarely	Count	0	4	2	6
		Expected Count	2.4	.2	3.4	6.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	95.034[a]	6	.000
Likelihood Ratio	45.534	6	.000
Linear-by-Linear Association	4.773	1	.029
N of Valid Cases	393		

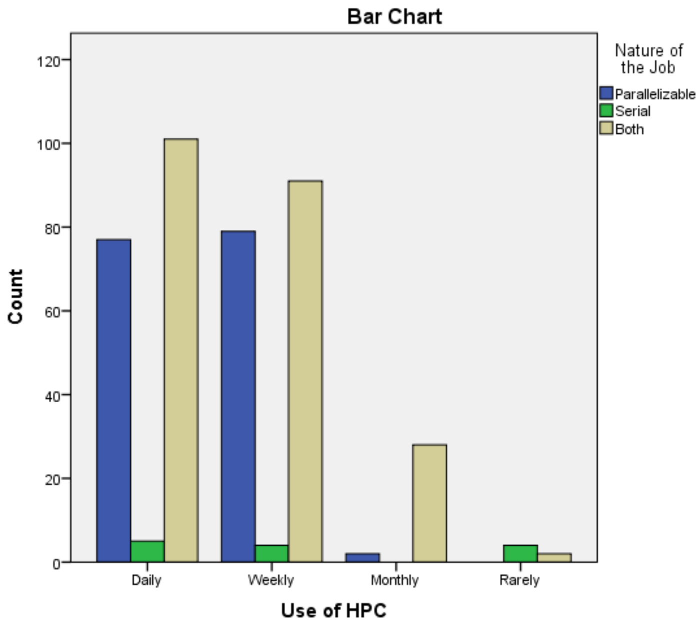


Figure 23 Use of HPC vs Nature of the Job

The above cross Table-51 exhibits statistically significant dependency (p-value =0.000) between the Use of HPC and Nature of the job.

H0 – Use of HPC and Nature of the job are independent.

H1 – Use of HPC and Nature of the job are dependent.

The Use of HPC and Nature of the job are significant.

The jobs which are expected to run long period like more than month usage of HPC is typically mixed category statistically significant more. An appropriate middleware management technology for customer to this to enhance the performance of the system.

Use of HPC * Security of the Data

Table 50: Use of HPC vs Security of the Data

			Security of the Data		
			Good	Excellent	Total
Use of HPC	Daily	Count	106	77	183
		Expected Count	102.0	81.0	183.0
	Weekly	Count	87	87	174
		Expected Count	97.0	77.0	174.0
	Monthly	Count	20	10	30
		Expected Count	16.7	13.3	30.0
	Rarely	Count	6	0	6
		Expected Count	3.3	2.7	6.0

Total	Count	219	174	393
	Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.893[a]	3	.031
Likelihood Ratio	11.167	3	.011
Linear-by-Linear Association	.453	1	.501
N of Valid Cases	393		

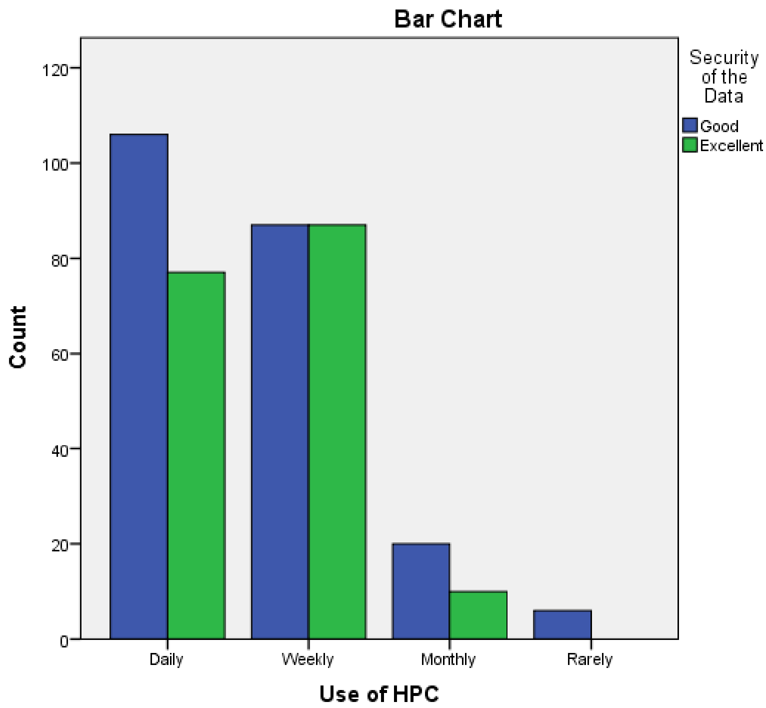


Figure 24 Use of HPC vs Security of the Data

The above Table-52 exhibits statistically significant dependency (p-value =0.031) between the Use of HPC and security of the Data.

H0 – Use of HPC and security of the Data are independent.

H1 – Use of HPC and security of the Data are dependent

The Use of HPC and security of the Data are significant.

The frequency of 'use of HPC' having relation with security of the Data. Frequent users expecting for better security of the Data than expected.

Use of HPC * Supercomputing Resource-1

Table 51: Use of HPC vs Supercomputing Resource-1

			Supercomputing Resource-1							Total
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	
Use of HPC	Daily	Count	29	20	24	15	44	10	21	163
		Expected Count	35.6	20.1	18.3	11.4	42.9	11.0	23.7	163.0
	Weekly	Count	39	23	13	6	42	14	23	160
		Expected Count	35.0	19.7	17.9	11.2	42.1	10.8	23.3	160.0
	Monthly	Count	9	1	3	2	7	0	8	30
		Expected Count	6.6	3.7	3.4	2.1	7.9	2.0	4.4	30.0
	Rarely	Count	1	0	0	2	1	0	0	4
		Expected Count	.9	.5	.4	.3	1.1	.3	.6	4.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.784[a]	18	.030
Likelihood Ratio	28.921	18	.049
Linear-by-Linear Association	.016	1	.899
N of Valid Cases	357		

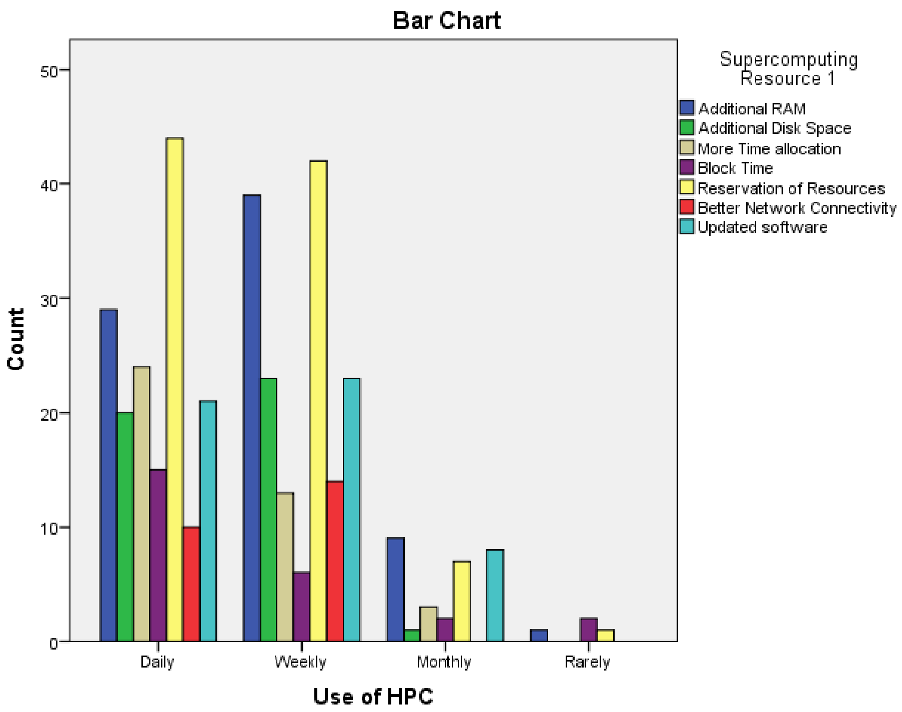


Figure 25 Use of HPC vs Supercomputing Resource-1

The above cross Table-53 exhibits statistically significant dependency (p-value =0.030) between the Use of HPC and Supercomputing Resource-1.

H0 – Use of HPC and Supercomputing Resource-1 are independent.

H1 – Use of HPC and Supercomputing Resource-1 are dependent

The Use of HPC and Supercomputing Resource-1 are significant.

From the above Table-56 the weekly users want additional RAM and daily user's wants to reservation of resources at University of Hyderabad High Performance Computing Facility.

Use of HPC * Supercomputing Resource-2

Table 52: Use of HPC vs Supercomputing Resource-2

			Supercomputing Resource - 2							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Use of HPC	Daily	Count	33	19	19	43	10	10	0	134
		Expected Count	34.4	17.4	13.4	40.3	11.0	14.9	2.5	134.0
	Weekly	Count	35	13	6	26	12	18	5	115
		Expected Count	29.5	15.0	11.5	34.6	9.4	12.8	2.1	115.0
	Monthly	Count	1	3	2	11	0	2	0	19

		Expected Count	4.9	2.5	1.9	5.7	1.6	2.1	.4	19.0
	Rarely	Count	0	0	0	1	0	0	0	1
		Expected Count	.3	.1	.1	.3	.1	.1	.0	1.0
Total		Count	69	35	27	81	22	30	5	269
		Expected Count	69.0	35.0	27.0	81.0	22.0	30.0	5.0	269.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.904[a]	18	.023
Likelihood Ratio	36.156	18	.007
Linear-by-Linear Association	3.080	1	.079
N of Valid Cases	269		

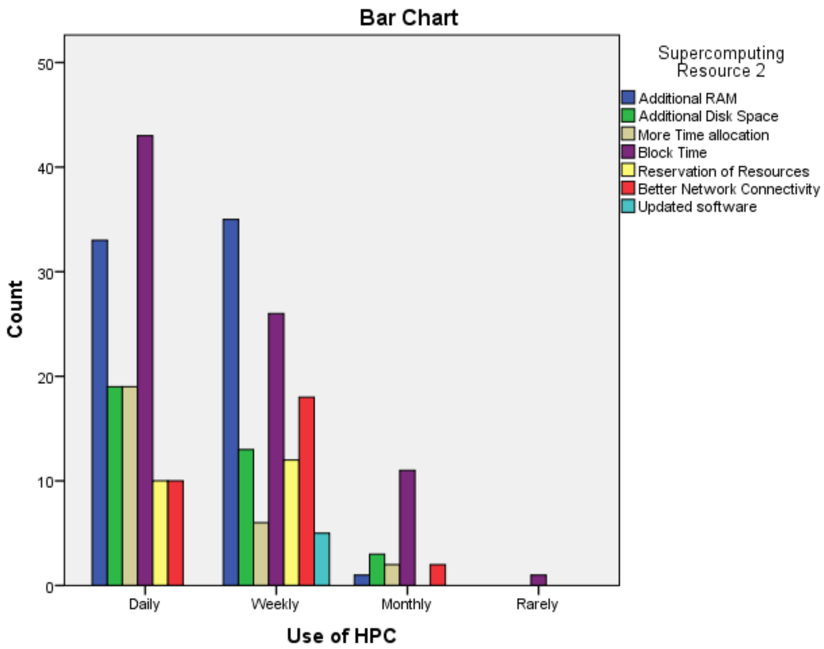


Figure 26 Use of HPC vs Supercomputing Resource-2

The above cross Table-54 exhibits statistically significant dependency (p-value =0.023) between the Use of HPC and Supercomputing Resource-2.

H0 – Use of HPC and Supercomputing Resource-2 are independent.

H1 – Use of HPC and Supercomputing Resource-2 are dependent

The Use of HPC and Supercomputing Resource-2 are significant.

Use of HPC * Supercomputing Resource-3

Table 53: Use of HPC vs Supercomputing Resource-3

			Supercomputing Resource -3					
			Additional RAM	Additional Disk Space	More Time allocation	Reservation of Resources	Updated software	Total
Use of HPC	Daily	Count	23	1	15	10	5	54
		Expected Count	23.5	2.3	14.1	11.7	2.3	54.0
	Weekly	Count	24	0	9	13	0	46
		Expected Count	20.0	2.0	12.0	10.0	2.0	46.0
	Monthly	Count	3	4	5	2	0	14
		Expected Count	6.1	.6	3.7	3.0	.6	14.0
	Rarely	Count	0	0	1	0	0	1
		Expected Count	.4	.0	.3	.2	.0	1.0
Total		Count	50	5	30	25	5	115
		Expected Count	50.0	5.0	30.0	25.0	5.0	115.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	35.303[a]	12	.000
Likelihood Ratio	28.943	12	.004
Linear-by-Linear Association	.572	1	.450
N of Valid Cases	115		

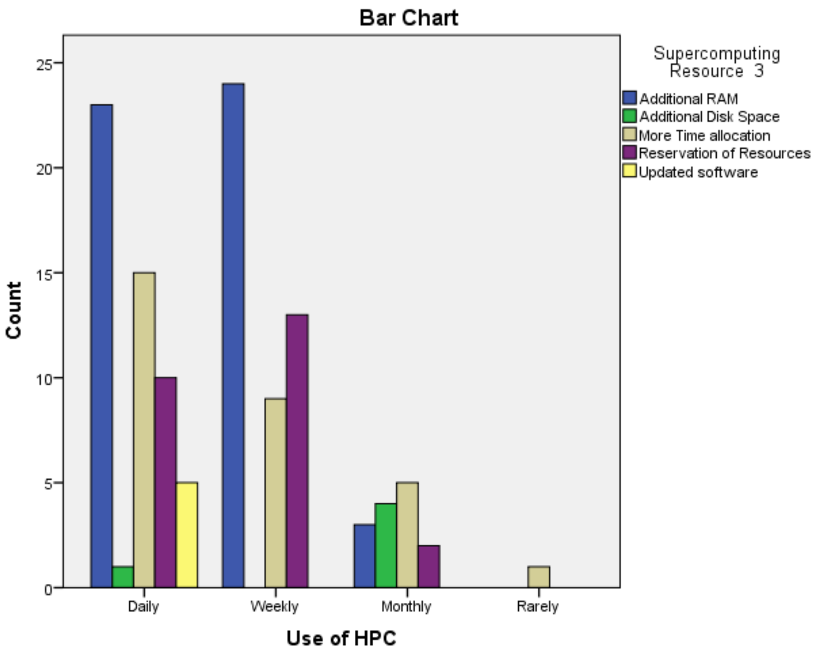


Figure 27 Use of HPC vs Supercomputing Resource-3

The above cross Table-55 exhibits statistically significant dependency (p-value =0.000) between the Use of HPC and Supercomputing Resource-3.

H0 – Use of HPC and Supercomputing Resource-3 are independent.

H1 – Use of HPC and Supercomputing Resource-3 are dependent

The Use of HPC and Supercomputing Resource-3 are significant.

From the above Table-55 the Users are requesting the more RAM, Disk space and updated software at University of Hyderabad High Performance Computing Facility.

Job Submission Process * Designation

Table 54: Job Submission Process vs Designation

			Designation			
			Research Scholar	Faculty	Student	Total
Job Submission Process	Excellent	Count	38	42	13	93
		Expected Count	40.9	37.6	14.4	93.0
	Satisfactory	Count	89	74	32	195
		Expected Count	85.8	78.9	30.3	195.0
	Moderate	Count	34	31	4	69
		Expected Count	30.4	27.9	10.7	69.0

	Complex	Count	12	12	12	36
		Expected Count	15.8	14.6	5.6	36.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.103[a]	6	.019
Likelihood Ratio	14.683	6	.023
Linear-by-Linear Association	.487	1	.485
N of Valid Cases	393		

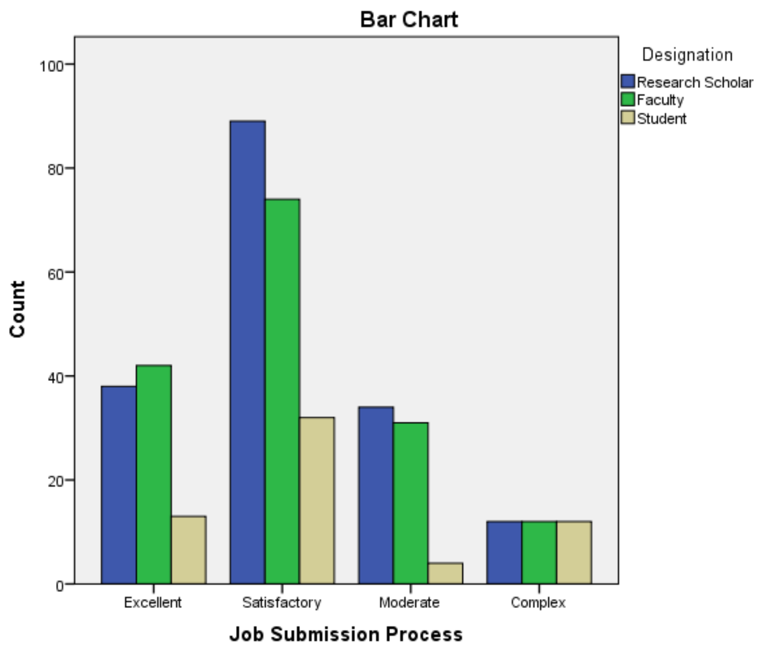


Figure 28 Job Submission Process vs Designation

The above cross Table-56 exhibits statistically significant dependency (p-value =0.019) between the Job Submission Process and Designation.

H0 – Job Submission Process and Designation are independent.

H1 – Job Submission Process and Designation are dependent

The Job Submission Process and Designation are significant.

The Research scholars expressing the Job Submission Process should be made more user-friendly.

Hence, this leads to the Job Submission Process level satisfaction to level of excellent.

Job Submission Process * Field of Research

Table 55: Job Submission Process vs Field of Research

			Field of Research							
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	Total
Job Submission Process	Excellent	Count	10	19	39	15	2	4	4	93
		Expected Count	7.6	21.8	30.3	25.6	5.0	.9	1.9	93.0
	Satisfactory	Count	17	47	62	56	13	0	0	195
		Expected Count	15.9	45.6	63.5	53.6	10.4	2.0	4.0	195.0
	Moderate	Count	2	16	21	22	4	0	4	69
		Expected Count	5.6	16.2	22.5	19.0	3.7	.7	1.4	69.0
	Complex	Count	3	10	6	15	2	0	0	36
		Expected Count	2.9	8.4	11.7	9.9	1.9	.4	.7	36.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

The above cross Table-57 exhibits statistically significant dependency (p-value =0.001) between the Job Submission Process and Field of Research.

H0 – Job Submission Process and Field of Research are independent.

H1 – Job Submission Process and Field of Research are dependent

The Job Submission Process and Field of Research are significant.

Job Submission Process * Group of Software Packages Used-4

Table 56: Job Submission Process vs Group of Software Packages Used-4

	Group of Software Packages Used-4	Total

			Economics Software	Software Packages-Chem/Physics/Enng Science	Software Packages - Life science	Software Packages - Physics Chemistry	
Job Submission Process	Excellent	Count	4	39	15	19	77
		Expected Count	2.3	29.3	24.8	20.6	77.0
	Satisfactory	Count	2	62	56	45	165
		Expected Count	4.9	62.9	53.0	44.2	165.0
	Moderate	Count	4	21	22	16	63
		Expected Count	1.9	24.0	20.3	16.9	63.0
	Complex	Count	0	6	15	10	31
		Expected Count	.9	11.8	10.0	8.3	31.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.997[a]	9	.018
Likelihood Ratio	21.209	9	.012
Linear-by-Linear Association	5.142	1	.023
N of Valid Cases	336		

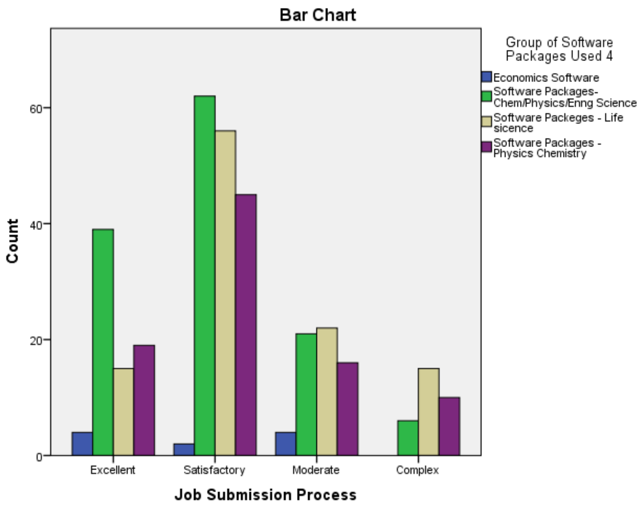


Figure 29 Job Submission Process vs Group of Software Packages Used-4

The above cross Table-58 exhibits statistically significant dependency (p-value =0.018) between the Group of Software Packages used4 and Job Submission Process.

H0 – Group of Software Packages used4 and Job Submission Process are independent.

H1 – Group of Software Packages used4 and Job Submission Process are dependent

The Group of Software Packages used4 and Job Submission Process are significant.

Job Submission Process * Year of Register

Table 57: Job Submission Process vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Job Submission Process	Excellent	Count	29	9	8	11	3	11	7	15	93
		Expected Count	25.6	15.1	8.8	14.7	6.9	5.9	8.8	7.3	93.0
	Satisfactory	Count	53	35	18	26	16	9	23	15	195
		Expected Count	53.6	31.8	18.4	30.8	14.4	12.4	18.4	15.4	195.0
	Moderate	Count	16	9	6	22	4	4	7	1	69
		Expected Count	19.0	11.2	6.5	10.9	5.1	4.4	6.5	5.4	69.0
	Complex	Count	10	11	5	3	6	1	0	0	36
		Expected Count	9.9	5.9	3.4	5.7	2.7	2.3	3.4	2.8	36.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	56.148[a]	21	.000
Likelihood Ratio	58.399	21	.000
Linear-by-Linear Association	7.991	1	.005
N of Valid Cases	393		

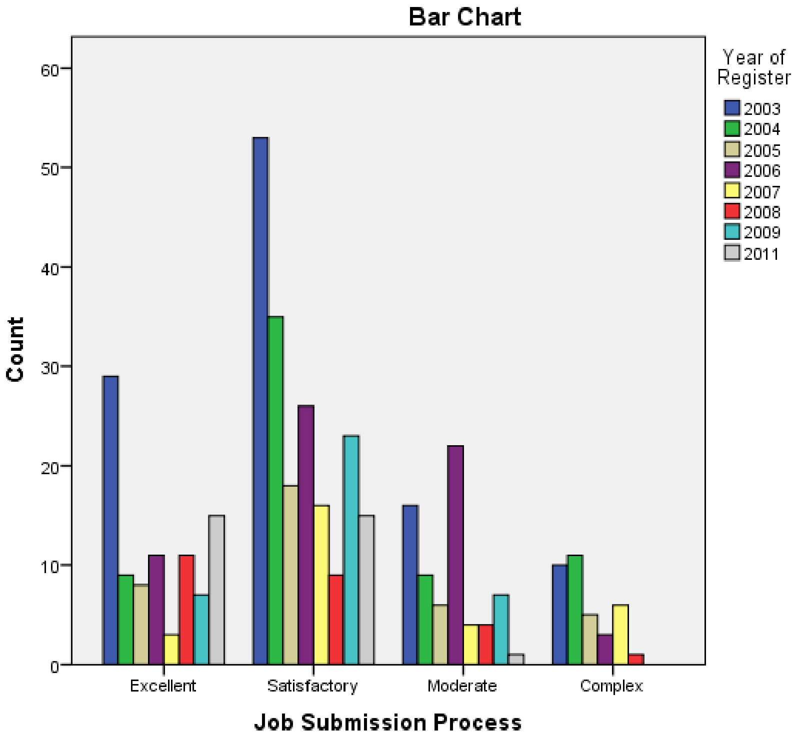


Figure 30 Job Submission Process vs Year of Register

The above cross Table-59 exhibits statistically significant dependency (p-value =0.000) between the Job Submission Process and Year of Register.

H0 – Job Submission Process and Year of Register are independent.

H1 – Job Submission Process and Year of Register are dependent

The Job Submission Process and Year of Register are significant.

Job Submission Process * Use of HPC

Table 58: Job Submission Process vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Job Submission Process	Excellent	Count	40	37	16	0	93
		Expected Count	43.3	41.2	7.1	1.4	93.0
	Satisfactory	Count	87	96	6	6	195
		Expected Count	90.8	86.3	14.9	3.0	195.0
	Moderate	Count	40	23	6	0	69

		Expected Count	32.1	30.5	5.3	1.1	69.0
	Complex	Count	16	18	2	0	36
		Expected Count	16.8	15.9	2.7	.5	36.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	28.873[a]	9	.001
Likelihood Ratio	29.824	9	.000
Linear-by-Linear Association	3.025	1	.082
N of Valid Cases	393		

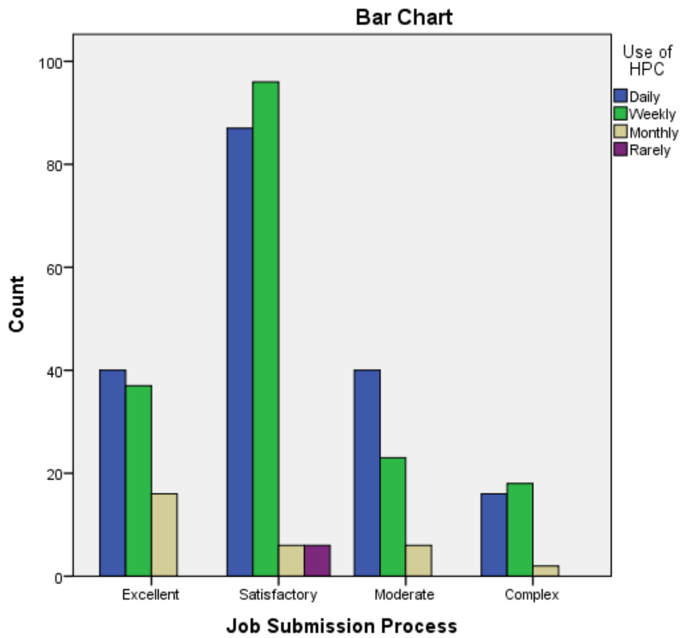


Figure 31 Job Submission Process vs Use of HPC

The above cross Table-60 exhibits statistically significant dependency (p-value =0.001) between the Job Submission Process and Use of HPC.

H0 – Job Submission Process and Use of HPC are independent.

H1 – Job Submission Process and Use of HPC are dependent

The Job Submission Process and Use of HPC are significant.

Job Submission Process * Financial Support

Table 59: Job Submission Process vs Financial Support

			Financial Support		
			Funding Agency	University - HPC	Total
Job Submission Process	Excellent	Count	30	63	93
		Expected Count	29.8	63.2	93.0
	Satisfactory	Count	73	122	195
		Expected Count	62.5	132.5	195.0
	Moderate	Count	17	52	69
		Expected Count	22.1	46.9	69.0
	Complex	Count	6	30	36
		Expected Count	11.5	24.5	36.0
Total		Count	126	267	393
		Expected Count	126.0	267.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.250[a]	3	.041
Likelihood Ratio	8.754	3	.033
Linear-by-Linear Association	4.098	1	.043
N of Valid Cases	393		

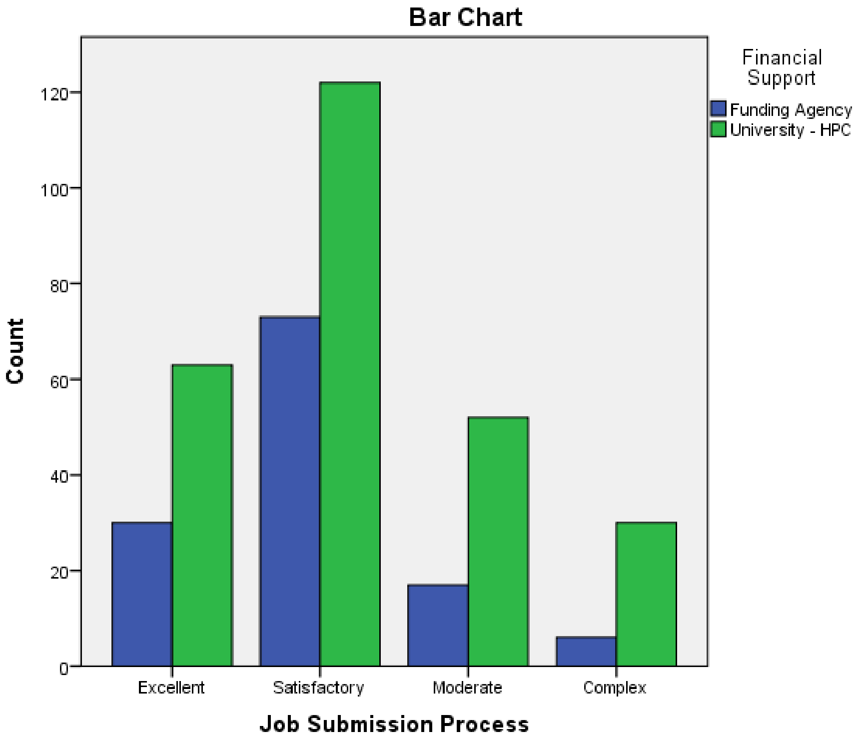


Figure 32 Job Submission Process vs Financial Support

The above cross Table-61 exhibits statistically significant dependency (p-value =0.041) between the Job Submission Process and Financial Support.

H0 – Job Submission Process and Financial Support are independent.

H1 – Job Submission Process and Financial Support are dependent

The Job Submission Process and Financial Support are significant.

Job Submission Process * Supercomputing Resource-1

Table 60: Job Submission Process vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Job Submission Process	Excellent	Count	23	11	10	10	26	5	8	93
		Expected Count	20.3	11.5	10.4	6.5	24.5	6.3	13.5	93.0
	Satisfactory	Count	42	26	18	10	31	15	25	167

		Expected Count	36.5	20.6	18.7	11.7	44.0	11.2	24.3	167.0
	Moderate	Count	11	6	5	3	21	2	17	65
		Expected Count	14.2	8.0	7.3	4.6	17.1	4.4	9.5	65.0
	Complex	Count	2	1	7	2	16	2	2	32
		Expected Count	7.0	3.9	3.6	2.2	8.4	2.2	4.7	32.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	40.525[a]	18	.002
Likelihood Ratio	40.855	18	.002
Linear-by-Linear Association	7.342	1	.007
N of Valid Cases	357		

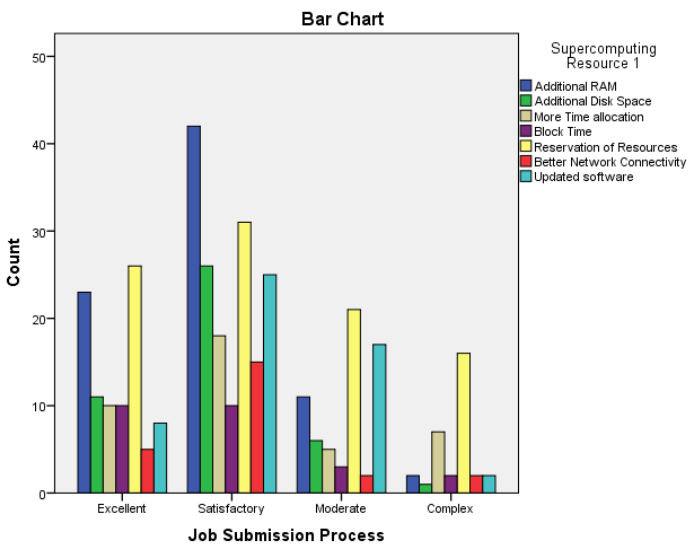


Figure 33 Job Submission Process vs Supercomputing Resource-1

The above cross Table-62 exhibits statistically significant dependency (p-value =0.002) between the Job Submission Process and Supercomputing Resource-1 are independent.

H1 – Job Submission Process and Supercomputing Resource-1are dependent

The Job Submission Process and Supercomputing Resource-1 are significant.

Security of Job * Nature of the Job

Table 61: Security of Job vs Nature of the Job

			Nature of the Job			Total
			Parallelizable	Serial	Both	
Security of Job	Good	Count	59	9	113	181
		Expected Count	72.8	6.0	102.2	181.0
	Excellent	Count	99	4	109	212
		Expected Count	85.2	7.0	119.8	212.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.737[a]	2	.008
Likelihood Ratio	9.835	2	.007
Linear-by-Linear Association	6.534	1	.011
N of Valid Cases	393		

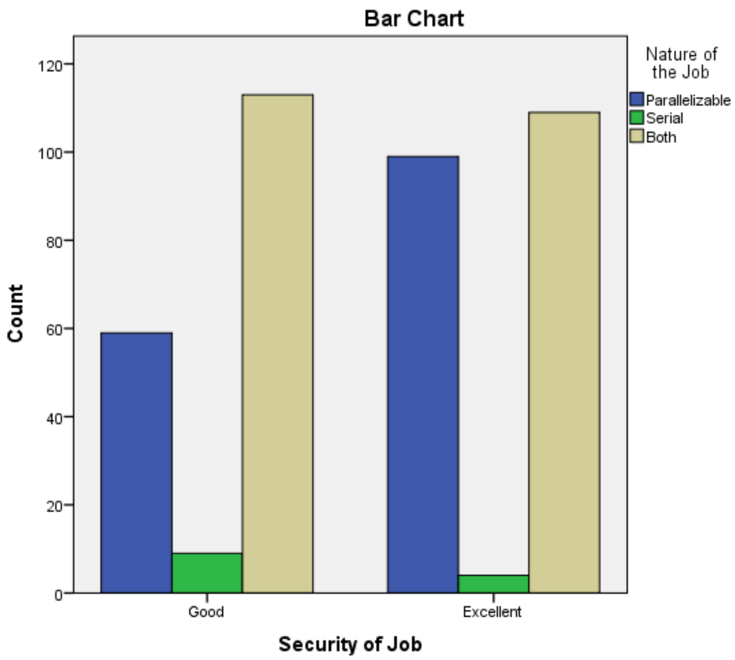


Figure 34 Security of Job vs Nature of the Job

The above cross Table-63 exhibits statistically significant dependency (p-value =0.008) between the Security of job and Nature of the job.

H0 – Security of job and Nature of the job are independent.

H1 – Security of job and Nature of the job are dependent

The Security of job and Nature of the job are significant.

Security of Job * Security of the Data

Table 62: Security of Job vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Security of Job	Good	Count	127	54	181
		Expected Count	100.9	80.1	181.0
	Excellent	Count	92	120	212
		Expected Count	118.1	93.9	212.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	28.359[a]	1	.000		
Continuity Correction[b]	27.285	1	.000		
Likelihood Ratio	28.842	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	28.287	1	.000		
N of Valid Cases	393				

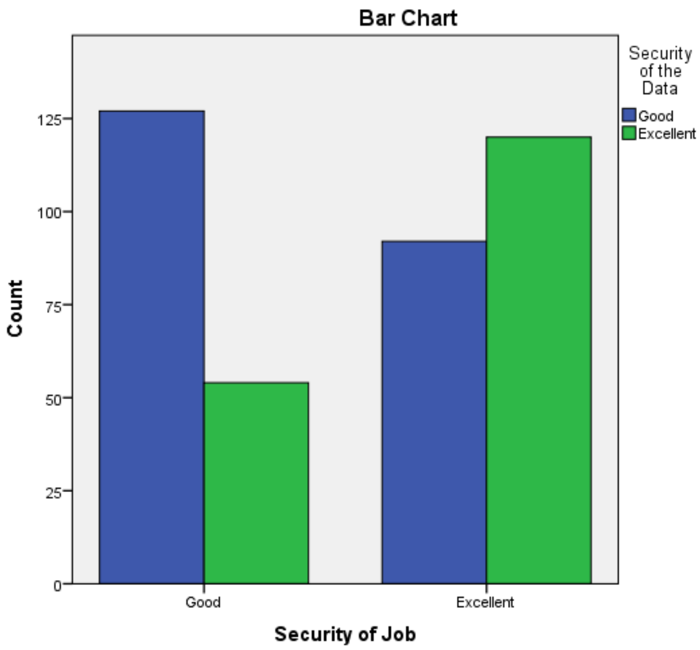


Figure 35 Security of Job vs Security of the Data

The above cross Table-64 exhibits statistically significant dependency (p-value =0.000) between the security of job and security of the data.

H0 – security of job and security of the data are independent.

H1 – security of job and security of the data are dependent

The security of job and security of the data are significant.

Security of Job * Supercomputing Resource-4

Table 63: Security of Job vs Supercomputing Resource-4

			Supercomputing Resource 4			
			Additional RAM	Additional Disk Space	More Time allocation	Total
Security of Job	Good	Count	15	12	0	27
		Expected Count	11.1	13.2	2.6	27.0
	Excellent	Count	6	13	5	24
		Expected Count	9.9	11.8	2.4	24.0
Total		Count	21	25	5	51
		Expected Count	21.0	25.0	5.0	51.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.751[a]	2	.013
Likelihood Ratio	10.780	2	.005
Linear-by-Linear Association	7.996	1	.005
N of Valid Cases	51		

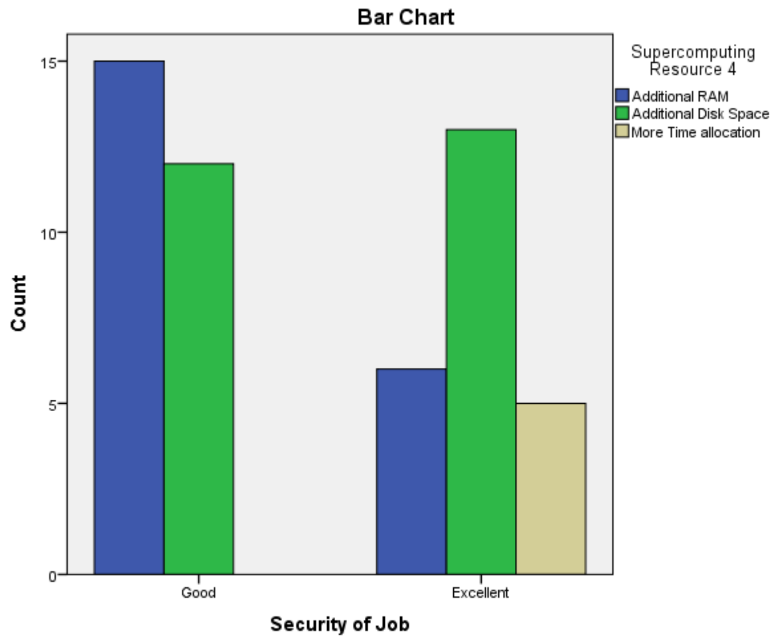


Figure 36 Security of Job vs Supercomputing Resource-4

The above cross Table-65 exhibits statistically significant dependency (p-value =0.013) between the Security of job and Supercomputing Resource-4.

H0 – Security of job and Supercomputing Resource-4 are independent.

H1 – Security of job and Supercomputing Resource-4 are dependent

The Security of job and Supercomputing Resource-4 are significant.

Security of the Data * Designation

Table 64: Security of the Data vs Designation

			Designation			
			Research Scholar	Faculty	Student	Total
Security of the Data	Good	Count	98	96	25	219
		Expected Count	96.4	88.6	34.0	219.0
	Excellent	Count	75	63	36	174
		Expected Count	76.6	70.4	27.0	174.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.827[a]	2	.033
Likelihood Ratio	6.796	2	.033
Linear-by-Linear Association	2.243	1	.134
N of Valid Cases	393		

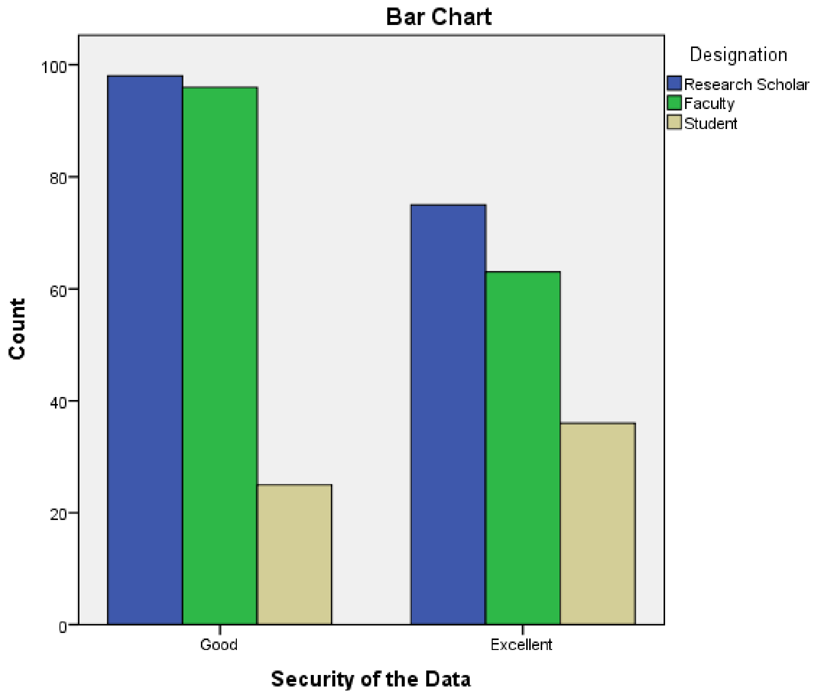


Figure 37 Security of the Data vs Designation

The above cross Table-66 exhibits statistically significant dependency (p-value =0.033) between the security of the data and Designation.

H0 – the security of the data and Designation are independent.

H1 – the security of the data and Designation are dependent

The security of the data and Designation are significant.

Security of the Data * Year of Register

Table 65: Security of the Data vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Security of the Data	Good	Count	61	31	18	27	14	14	28	26	219
		Expected Count	60.2	35.7	20.6	34.5	16.2	13.9	20.6	17.3	219.0
	Excellent	Count	47	33	19	35	15	11	9	5	174

		Expected Count	47.8	28.3	16.4	27.5	12.8	11.1	16.4	13.7	174.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.455[a]	7	.002
Likelihood Ratio	23.998	7	.001
Linear-by-Linear Association	8.855	1	.003
N of Valid Cases	393		

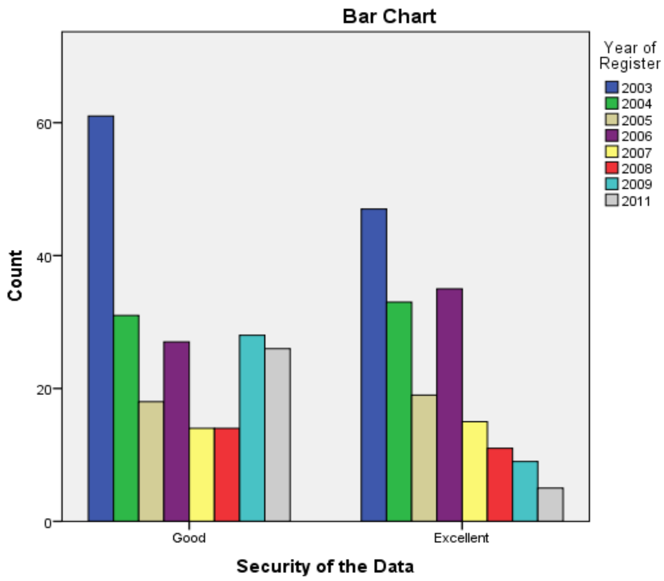


Figure 38 Security of the Data vs Year of Register

The above cross Table-67 exhibits statistically significant dependency (p-value = 0.002) between the security of the data and Year of Register.

H0 – security of the data and Year of Register are independent.

H1 – security of the data and Year of Register are dependent

The security of the data and Year of Register are significant.

Security of the Data * Use of HPC

Table 66: Security of the Data vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Security of the Data	Good	Count	106	87	20	6	219
		Expected Count	102.0	97.0	16.7	3.3	219.0
	Excellent	Count	77	87	10	0	174
		Expected Count	81.0	77.0	13.3	2.7	174.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.893[a]	3	.031
Likelihood Ratio	11.167	3	.011
Linear-by-Linear Association	.453	1	.501
N of Valid Cases	393		

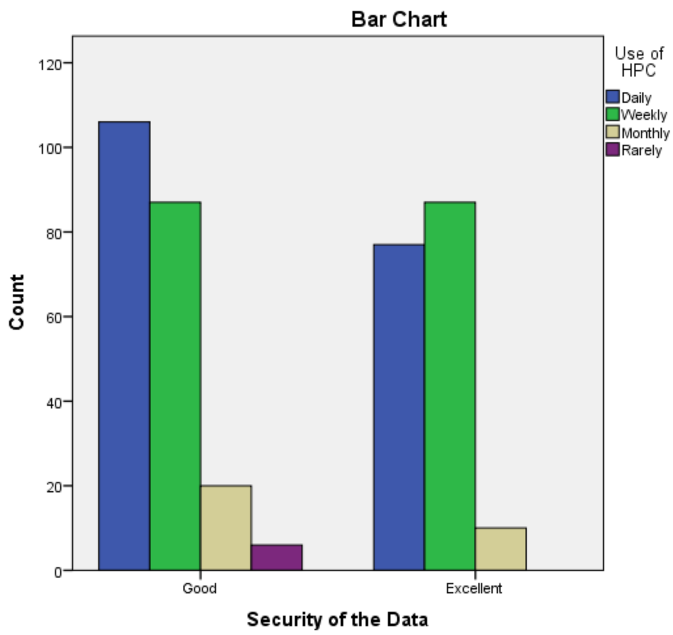


Figure 39 Security of the Data vs Use of HPC

The above cross Table-68 exhibits statistically significant dependency (p-value= 0.031) between the security of the data and Use of HPC.

H0 – security of the data and Use of HPC are independent.

H1 – security of the data and Use of HPC are dependent

The security of the data and Use of HPC are significant.

Security of the Data * Security of Job

Table 67: Security of the Data vs Security of Job

			Security of Job		Total
			Good	Excellent	
Security of the Data	Good	Count	127	92	219
		Expected Count	100.9	118.1	219.0
	Excellent	Count	54	120	174
		Expected Count	80.1	93.9	174.0
Total		Count	181	212	393
		Expected Count	181.0	212.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	28.359[a]	1	.000		
Continuity Correction[b]	27.285	1	.000		
Likelihood Ratio	28.842	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	28.287	1	.000		
N of Valid Cases	393				

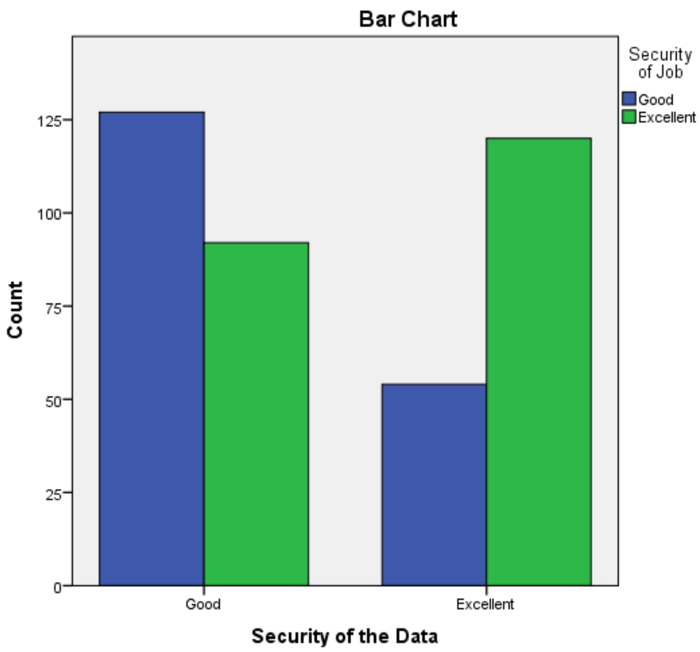


Figure 40 Security of the Data vs Security of Job

The above cross Table-69 exhibits statistically significant dependency (p-value =0.000) between the security of the data and Security of job.

H0 – security of the data and Security of job are independent.

H1 – security of the data and Security of job are dependent

The security of the data and Security of job are significant.

Infrastructural Facility * Designation

Table 68: Infrastructural Facility vs Designation

			Designation			Total
			Research Scholar	Faculty	Student	
Infrastructural Facility	3	Count	57	25	3	85
		Expected Count	37.4	34.4	13.2	85.0
	4	Count	102	119	52	273
		Expected Count	120.2	110.5	42.4	273.0
	5	Count	14	15	6	35
		Expected Count	15.4	14.2	5.4	35.0
Total		Count	173	159	61	393
		Expected Count	173.0	159.0	61.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	46.156[a]	14	.000
Likelihood Ratio	53.213	14	.000
Linear-by-Linear Association	4.761	1	.029
N of Valid Cases	393		

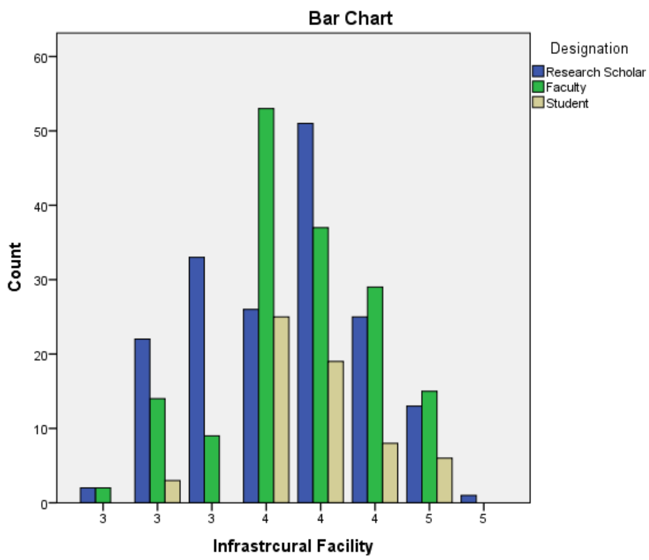


Figure 41 Infrastructural Facility vs Designation

The above cross Table-70 exhibits statistically significant dependency (p-value =0.000) between the Designation and Infrastructural Facility.

H0 – Designation and Infrastructural Facility are independent.

H1 – Designation and Infrastructural Facility are dependent

The Designation and Infrastructural Facility are significant.

Infrastructural Facility * Year of Register

Table 69: Infrastructural Facility vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
Infrastructural Facility	3	Count	14	11	5	25	2	4	14	10	85
		Expected Count	23.4	13.8	8.0	13.4	6.3	5.4	8.0	6.7	85.0
	4	Count	84	50	29	30	23	18	19	20	273
		Expected Count	75.0	44.5	25.7	43.1	20.1	17.4	25.7	21.5	273.0
	5	Count	10	3	3	7	4	3	4	1	35
		Expected Count	9.6	5.7	3.3	5.5	2.6	2.2	3.3	2.8	35.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	93.451[a]	49	.000
Likelihood Ratio	90.047	49	.000
Linear-by-Linear Association	3.358	1	.067
N of Valid Cases	393		

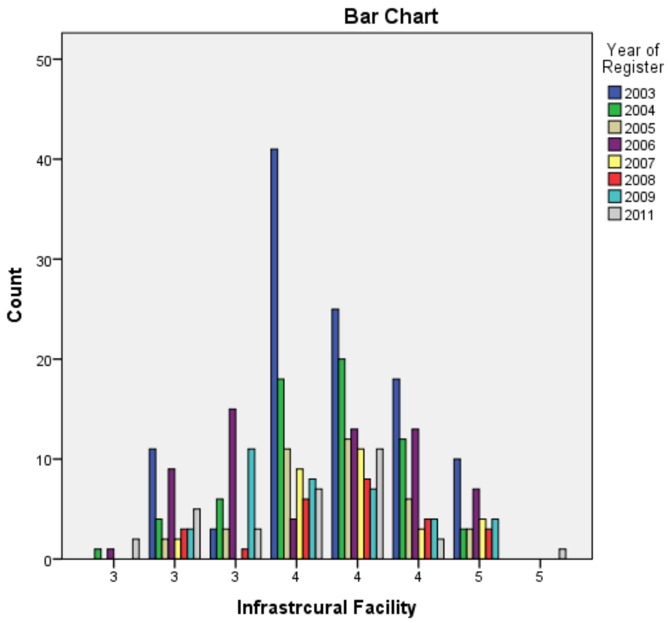


Figure 42 Infrastructural Facility vs Year of Register

The above cross Table-71 exhibits statistically significant dependency (p-value =0.001) between the Infrastructural Facility and Year of Register.

H0 – Infrastructural Facility and Year of Register are independent.

H1 – Infrastructural Facility and Year of Register are dependent.

The Infrastructural Facility and Year of Register are significant.

Infrastructural Facility * Use of HPC

Table 70: Infrastructural Facility vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
Infrastructural Facility	3	Count	30	45	6	4	85
		Expected Count	39.6	37.6	6.5	1.3	85.0
	4	Count	130	121	20	2	273
		Expected Count	127.1	120.9	20.8	4.2	273.0
	5	Count	23	8	4	0	35
		Expected Count	16.3	15.5	2.7	.5	35.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	45.700[a]	21	.001
Likelihood Ratio	41.517	21	.005
Linear-by-Linear Association	7.754	1	.005
N of Valid Cases	393		

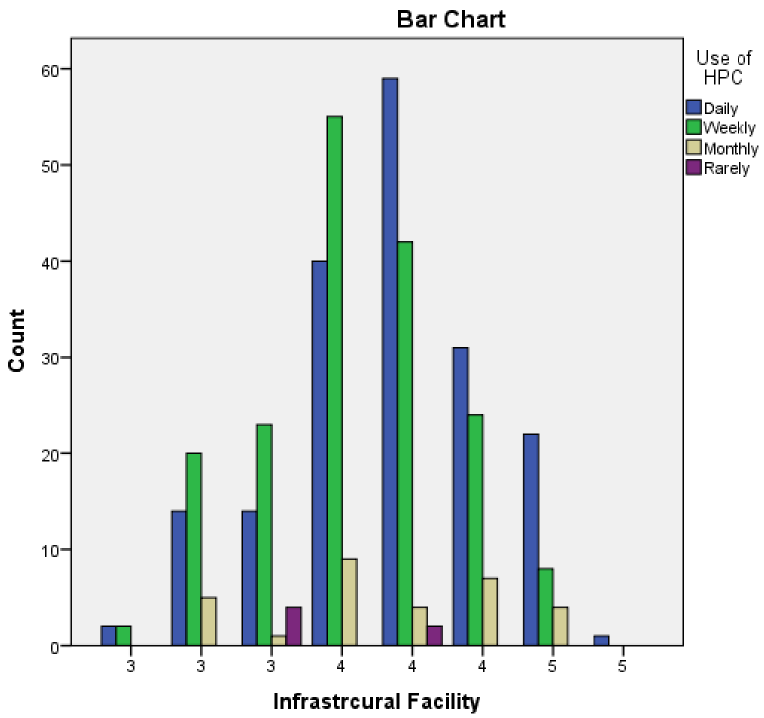


Figure 43 Infrastructural Facility vs Use of HPC

The above cross Table-72 exhibits statistically significant dependency (p-value =0.006) between the Infrastructural Facility and Use of HPC.

H0 – Infrastructural Facility and Use of HPC are independent.

H1 – Infrastructural Facility and Use of HPC are dependent.

The Infrastructural Facility and Use of HPC are significant.

Infrastructural Facility * Job Submission Process

Table 71: Infrastructural Facility vs Job Submission Process

			Job Submission Process				Total
			Excellent	Satisfactory	Moderate	Complex	
Infrastructural Facility	3	Count	20	43	19	3	85
		Expected Count	20.1	42.2	14.9	7.8	85.0
	4	Count	71	127	45	30	273
		Expected Count	64.6	135.5	47.9	25.0	273.0
	5	Count	2	25	5	3	35
		Expected Count	8.3	17.4	6.1	3.2	35.0
Total		Count	93	195	69	36	393
		Expected Count	93.0	195.0	69.0	36.0	393.0

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.722[a]	21	.011
Likelihood Ratio	42.586	21	.004
Linear-by-Linear Association	2.466	1	.116
N of Valid Cases	393		

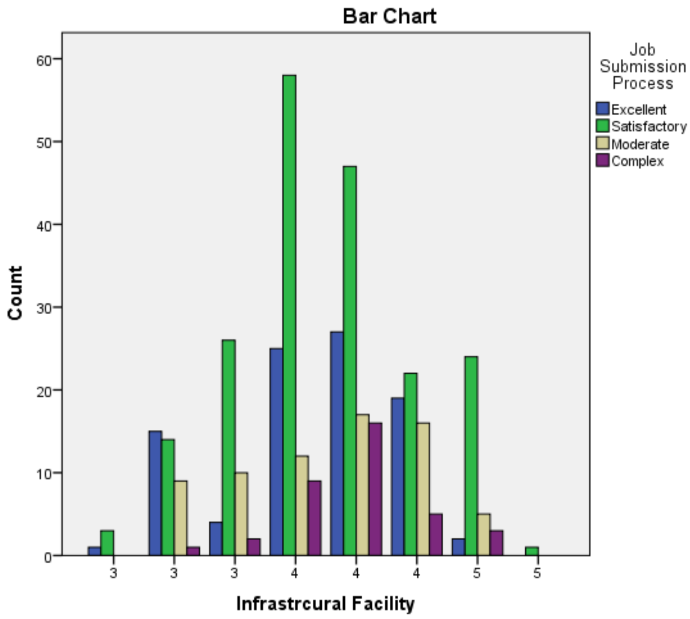


Figure 44 Infrastructural Facility vs Job Submission Process

The above cross Table-73 exhibits statistically significant dependency (p-value =0.022) between the Infrastructural Facility and Job Submission Process

H0 – Infrastructural Facility and Job Submission Process are independent.

H1 – Infrastructural Facility and Job Submission Process are dependent

The Infrastructural Facility and Job Submission Process are significant.

Infrastructural Facility * Security of the Data

Table 72: Infrastructural Facility vs Security of the Data

			Security of the Data		Total
			Good	Excellent	
Infrastructural Facility	3	Count	37	48	85
		Expected Count	47.4	37.6	85.0
	4	Count	157	116	273
		Expected Count	152.1	120.9	273.0
	5	Count	25	10	35
		Expected Count	19.5	15.5	35.0
Total		Count	219	174	393
		Expected Count	219.0	174.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.329[a]	7	.005
Likelihood Ratio	20.951	7	.004
Linear-by-Linear Association	3.083	1	.079
N of Valid Cases	393		

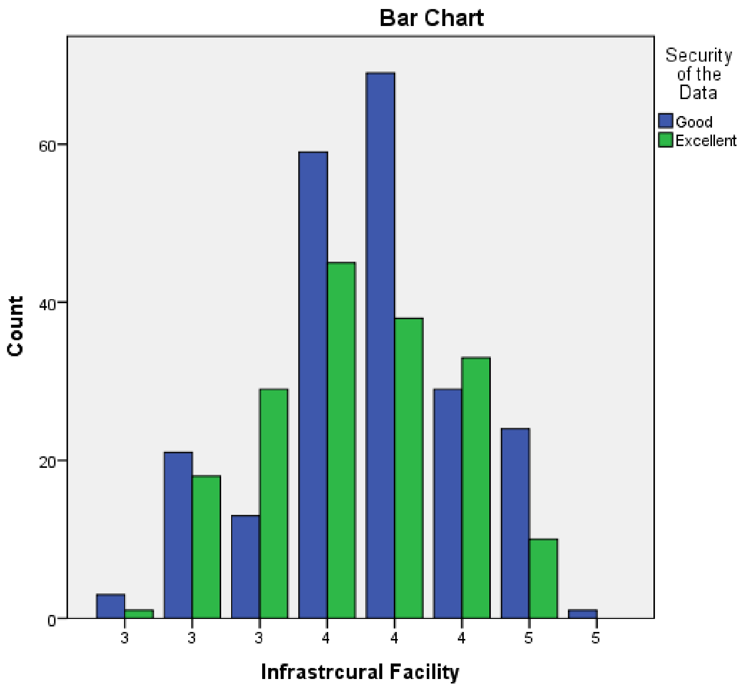


Figure 45 Infrastructural Facility vs Security of the Data

The above cross Table-74 exhibits statistically significant dependency (p-value =0.005) between the Infrastructural Facility and Security of the Data**.**

H0 – Infrastructural Facility and Security of the Data are independent.

H1 – Infrastructural Facility and Security of the Data are dependent.

The Infrastructural Facility and Security of the Data is significant.

Infrastructural Facility * Application Parallel or Serial

Table 73: Infrastructural Facility vs Application Parallel or Serial

	Application Parallel or Serial		Total
	Parallel	Serial	

Infrastructural Facility	3	Count	37	48	85
		Expected Count	50.6	34.4	85.0
	4	Count	170	103	273
		Expected Count	162.5	110.5	273.0
	5	Count	27	8	35
		Expected Count	20.8	14.2	35.0
Total		Count	234	159	393
		Expected Count	234.0	159.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	19.516[a]	7	.007
Likelihood Ratio	19.937	7	.006
Linear-by-Linear Association	6.286	1	.012
N of Valid Cases	393		

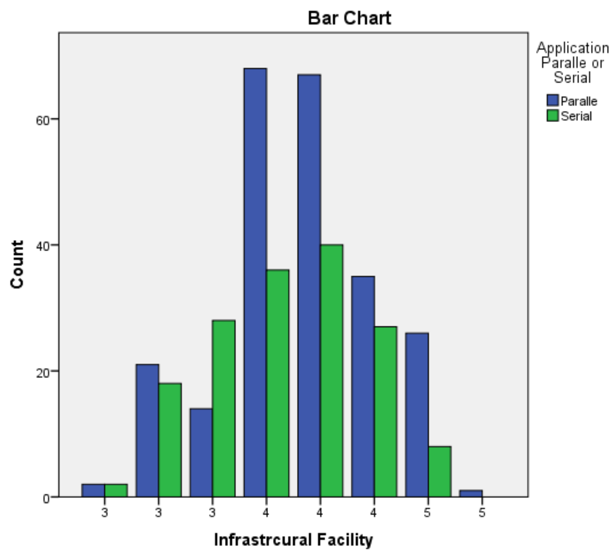


Figure 46 Infrastructural Facility vs Application Parallel or Serial

The above cross Table-75 exhibits statistically significant dependency (p-value =0.007) between the Infrastructural Facility and Application Parallel or Serial.

H0 – Infrastructural Facility and Application Parallel or Serial are independent.

H1 – Infrastructural Facility and Application Parallel or Serial are dependent.

The Infrastructural Facility and Application Parallel or Serial is significant.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Application Parallel or Serial * Organization	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Field of Research	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 2	361	91.9%	32	8.1%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 3	336	85.5%	57	14.5%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 4	336	85.5%	57	14.5%	393	100.0%
Application Parallel or Serial * Group of Software Packages Used 5	224	57.0%	169	43.0%	393	100.0%
Application Parallel or Serial * Year of Register	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Nature of the Job	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Financial Support	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Infrastructural Facility	393	100.0%	0	0.0%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 1	357	90.8%	36	9.2%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 2	269	68.4%	124	31.6%	393	100.0%
Application Parallel or Serial * Supercomputing Resource 3	115	29.3%	278	70.7%	393	100.0%

Application Parallel or Serial * Organization

Table 74: Application Parallel or Serial vs Organization

			Organization		
			UNIVERSITY OF HYDERABAD	Other	Total
Application Parallel or Serial	Parallel	Count	192	42	234
		Expected Count	199.5	34.5	234.0
	Serial	Count	143	16	159
		Expected Count	135.5	23.5	159.0
Total		Count	335	58	393
		Expected Count	335.0	58.0	393.0

The above cross Table-76 exhibits statistically significant dependency (p-value =0.031) between the Application Parallel or Serial and Organization.

H0 – Application Parallel or Serial and Organization are independent.

H1 – Application Parallel or Serial and Organization are dependent

The Application Parallel or Serial and Organization are significant.

Application Parallel or Serial * Field of Research

Table 75: Application Parallel or Serial vs Field of Research

			Field of Research							Total
			School of Mathematics and Statistics	School of Physics	School of Chemistry	School of Life Sciences	School of Engineering Sciences and Technology	School of Economics	School of Computer and Information Sciences	
Application Parallel or Serial	Parallel	Count	18	42	79	70	17	4	4	234
		Expected Count	19.1	54.8	76.2	64.3	12.5	2.4	4.8	234.0
	Serial	Count	14	50	49	38	4	0	4	159
		Expected Count	12.9	37.2	51.8	43.7	8.5	1.6	3.2	159.0
Total		Count	32	92	128	108	21	4	8	393
		Expected Count	32.0	92.0	128.0	108.0	21.0	4.0	8.0	393.0

The above cross Table-77 exhibits statistically significant dependency (p-value =0.014) between the Application Parallel or Serial and Field of Research.

H0 – Application Parallel or Serial and Field of Research are independent.

H1 – Application Parallel or Serial and Field of Research are dependent

The Application Parallel or Serial and Field of Research are significant.

Application Parallel or Serial * Group of Software Packages Used-2

Table 76: Application Parallel or Serial vs Group of Software Packages Used-2

	Group of Software Packages Used-2	Total

			Software Packages-Chem-Life Sciences	Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Economics Software	
Application Parallel or Serial	Parallel	Count	149	29	34	4	216
		Expected Count	141.2	40.1	32.3	2.4	216.0
	Serial	Count	87	38	20	0	145
		Expected Count	94.8	26.9	21.7	1.6	145.0
Total		Count	236	67	54	4	361
		Expected Count	236.0	67.0	54.0	4.0	361.0

The above cross Table-78 exhibits statistically significant dependency (p-value =0.009) between the Application Parallel or Serial and Group Software Packages Used-2.

H0 – Application Parallel or Serial and Group Software Packages Used-2 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-2 are dependent

The Application Parallel or Serial and Group Software Packages Used-2 are significant.

Application Parallel or Serial * Group of Software Packages Used-3

Table 77: Application Parallel or Serial vs Group of Software Packages Used-3

			Group of Software Packages Used-3			
			Software Packages-Chem/Physics/Life Science	Engg and Earth Science	Software Packages-Chem/Physics/Enng Science	Total
Application Parallel or Serial	Parallel	Count	149	4	42	195
		Expected Count	137.0	5.8	52.2	195.0
	Serial	Count	87	6	48	141
		Expected Count	99.0	4.2	37.8	141.0
Total		Count	236	10	90	336
		Expected Count	236.0	10.0	90.0	336.0

The above cross Table-79 exhibits statistically significant dependency (p-value =0.013) between the Application Parallel or Serial and Group Software Packages Used-3.

H0 – Application Parallel or Serial and Group Software Packages Used-3 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-3 are dependent

The Application Parallel or Serial and Group Software Packages Used-3 are significant.

Application Parallel or Serial * Group of Software Packages Used-4

Table 78: Application Parallel or Serial vs Group of Software Packages Used-4

			Group of Software Packages Used-4				
			Economics Software	Software Packages-Chem/Physics/Enng Science	Software Packages - Life science	Software Packages - Physics Chemistry	Total
Application Parallel or Serial	Parallel	Count	4	79	70	42	195
		Expected Count	5.8	74.3	62.7	52.2	195.0
	Serial	Count	6	49	38	48	141
		Expected Count	4.2	53.7	45.3	37.8	141.0
Total		Count	10	128	108	90	336
		Expected Count	10.0	128.0	108.0	90.0	336.0

The above cross Table-80 exhibits statistically significant dependency (p-value =0.031) between the Application Parallel or Serial and Group Software Packages Used-4.

H0 – Application Parallel or Serial and Group Software Packages Used-4 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-4 are dependent

The Application Parallel or Serial and Group Software Packages Used-4 are significant.

Application Parallel or Serial * Group of Software Packages Used-5

Table 79: Application Parallel or Serial vs Group of Software Packages Used-5

			Group of Software Packages Used-5			Total
			Software Packages - Physics Chemistry	Software Packages - Electronics and Physics	Software Packages - Maths/Physics/Electronics	
Application Parallel or Serial	Parallel	Count	79	0	42	121
		Expected Count	69.1	2.2	49.7	121.0
	Serial	Count	49	4	50	103
		Expected Count	58.9	1.8	42.3	103.0
Total		Count	128	4	92	224
		Expected Count	128.0	4.0	92.0	224.0

The above cross Table-81 exhibits statistically significant dependency (p-value =0.006) between the Application Parallel or Serial and Group Software Packages Used-5.

H0 – Application Parallel or Serial and Group Software Packages Used-5 are independent.

H1 – Application Parallel or Serial and Group Software Packages Used-5are dependent

The Application Parallel or Serial and Group Software Packages Used-5 are significant.

Application Parallel or Serial * Year of Register

Table 80: Application Parallel or Serial vs Year of Register

			Year of Register								Total
			2003	2004	2005	2006	2007	2008	2009	2011	
	Parallel	Count	69	28	21	44	19	16	17	20	234

Application Parallel or Serial		Expected Count	64.3	38.1	22.0	36.9	17.3	14.9	22.0	18.5	234.0
	Serial	Count	39	36	16	18	10	9	20	11	159
		Expected Count	43.7	25.9	15.0	25.1	11.7	10.1	15.0	12.5	159.0
Total		Count	108	64	37	62	29	25	37	31	393
		Expected Count	108.0	64.0	37.0	62.0	29.0	25.0	37.0	31.0	393.0

The above cross Table-82 exhibits statistically significant dependency (p-value =0.039) between the Application Parallel or Serial and Year of Register.

H0 – Application Parallel or Serial and Year of Register are independent.

H1 – Application Parallel or Serial and Year of Register are dependent

The Application Parallel or Serial and Year of Register are significant.

Application Parallel or Serial * Nature of the Job

Table 81: Application Parallel or Serial vs Nature of the Job

			Nature of the Job			Total
			Parallelizable	Serial	Both	
Application Parallel or Serial	Parallel	Count	113	7	114	234
		Expected Count	94.1	7.7	132.2	234.0
	Serial	Count	45	6	108	159
		Expected Count	63.9	5.3	89.8	159.0
Total		Count	158	13	222	393
		Expected Count	158.0	13.0	222.0	393.0

The above cross Table-83 exhibits statistically significant dependency (p-value =0.000) between the Application Parallel or Serial and Nature of the Job.

H0 – Application Parallel or Serial and Nature of the Job are independent.

H1 – Application Parallel or Serial and Nature of the Job are dependent

The Application Parallel or Serial and Nature of the Job are significant.

Application Parallel or Serial * Financial Support

Table 82: Application Parallel or Serial vs Financial Support

			Financial Support		Total
			Funding Agency	University - HPC	
	Parallel	Count	63	171	234

Application Parallel or Serial		Expected Count	75.0	159.0	234.0
	Serial	Count	63	96	159
		Expected Count	51.0	108.0	159.0
Total		Count	126	267	393
		Expected Count	126.0	267.0	393.0

The above cross Table-84 exhibits statistically significant dependency (p-value =0.008) between the Application Parallel or Serial and Financial Support.

H0 – Application Parallel or Serial and Financial Support are independent.

H1 – Application Parallel or Serial and Financial Support are dependent

The Application Parallel or Serial and Financial Support are significant.

Application Parallel or Serial * Supercomputing Resource-1

Table 83: Application Parallel or Serial vs Supercomputing Resource-1

			Supercomputing Resource-1							
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	Total
Application Parallel or Serial	Parallel	Count	47	26	28	11	73	12	27	224
		Expected Count	48.9	27.6	25.1	15.7	59.0	15.1	32.6	224.0
	Serial	Count	31	18	12	14	21	12	25	133
		Expected Count	29.1	16.4	14.9	9.3	35.0	8.9	19.4	133.0
Total		Count	78	44	40	25	94	24	52	357
		Expected Count	78.0	44.0	40.0	25.0	94.0	24.0	52.0	357.0

The above cross Table-85 exhibits statistically significant dependency (p-value =0.005) between the Application Parallel or Serial and Supercomputing Resource-1.

H0 – Application Parallel or Serial and Supercomputing Resource-1 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-1 are dependent

The Application Parallel or Serial and Supercomputing Resource-1 are significant.

Application Parallel or Serial * Supercomputing Resource-2

Table 84: Application Parallel or Serial vs Supercomputing Resource-2

			Supercomputing Resource-2							Total
			Additional RAM	Additional Disk Space	More Time allocation	Block Time	Reservation of Resources	Better Network Connectivity	Updated software	
Application Parallel or Serial	Parallel	Count	33	23	11	64	16	17	5	169
		Expected Count	43.3	22.0	17.0	50.9	13.8	18.8	3.1	169.0
	Serial	Count	36	12	16	17	6	13	0	100
		Expected Count	25.7	13.0	10.0	30.1	8.2	11.2	1.9	100.0
Total		Count	69	35	27	81	22	30	5	269
		Expected Count	69.0	35.0	27.0	81.0	22.0	30.0	5.0	269.0

The above cross Table-86 exhibits statistically significant dependency (p-value =0.000) between the Application Parallel or Serial and Supercomputing Resource-2.

H0 – Application Parallel or Serial and Supercomputing Resource-2 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-2 are dependent

The Application Parallel or Serial and Supercomputing Resource-2 are significant.

Application Parallel or Serial * Supercomputing Resource-3

Table 85: Application Parallel or Serial vs Supercomputing Resource-3

			Supercomputing Resource -3					Total
			Additional RAM	Additional Disk Space	More Time allocation	Reservation of Resources	Updated software	
Application Parallel or Serial	Parallel	Count	22	4	24	12	5	67
		Expected Count	29.1	2.9	17.5	14.6	2.9	67.0
	Serial	Count	28	1	6	13	0	48
		Expected Count	20.9	2.1	12.5	10.4	2.1	48.0
Total		Count	50	5	30	25	5	115
		Expected Count	50.0	5.0	30.0	25.0	5.0	115.0

The above cross Table-87 exhibits statistically significant dependency (p-value =0.004) between the Application Parallel or Serial and Supercomputing Resource-3.

H0 – Application Parallel or Serial and Supercomputing Resource-3 are independent.

H1 – Application Parallel or Serial and Supercomputing Resource-3 are dependent

The Application Parallel or Serial and Supercomputing Resource-3 are significant.

HPC Rating * Use of HPC

Table 86: HPC Rating vs Use of HPC

			Use of HPC				Total
			Daily	Weekly	Monthly	Rarely	
HPC Rating	3	Count	9	13	8	0	30
		Expected Count	14.0	13.3	2.3	.5	30.0
	4	Count	168	156	22	6	352
		Expected Count	163.9	155.8	26.9	5.4	352.0
	5	Count	6	5	0	0	11
		Expected Count	5.1	4.9	.8	.2	11.0
Total		Count	183	174	30	6	393
		Expected Count	183.0	174.0	30.0	6.0	393.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	99.918[a]	36	.000
Likelihood Ratio	86.053	36	.000
Linear-by-Linear Association	15.790	1	.000
N of Valid Cases	393		

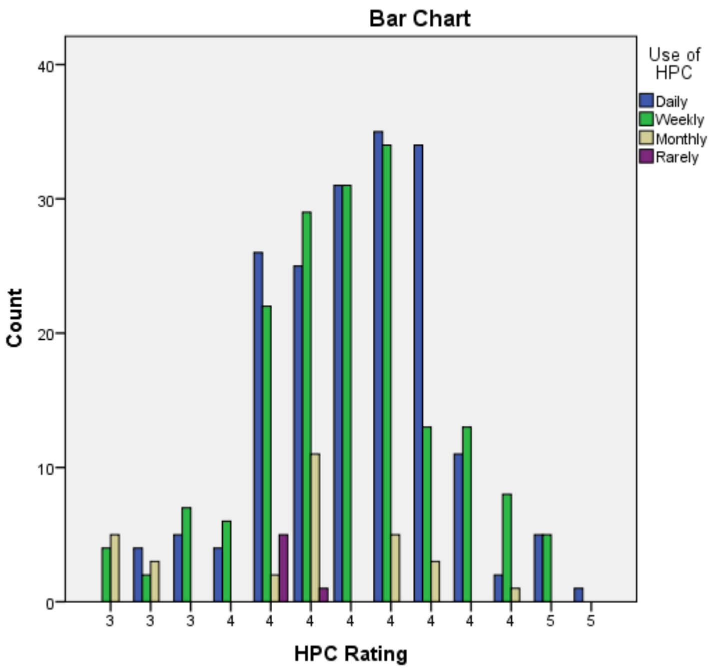


Figure 47 HPC Rating vs Use of HPC

The above cross Table-88 exhibits statistically significant dependency (p-value =0.000) between the HPC Rating and Use of HPC.

H0 – HPC Rating and Use of HPC are independent.

H1 – HPC Rating and Use of HPC are dependent

The HPC Rating and Use of HPC are significant.

5.4 Hypothesis and Inference

According to the problem of study, the following null hypotheses are formulated to analysis the system, to arrive the answers to some of questions.

The e-CRM effect pertaining to software packages availability, accessing facility, usage of facility, personalization and fulfillment of requirements on customer satisfaction in HPCF.

H_0^1: There is no significant effect of the software packages availability on customer satisfaction in HPCF.

H_0^2: There is no significant effect of the accessing facility on customer satisfaction in HPCF.

H_0^3: There is no significant effect of the usage of facility on customer satisfaction in HPCF.

H_0^4: There is no significant effect of the personalization on customer satisfaction in HPCF.

H_0^5: There is no significant effect of the fulfillment of requirements on customer satisfaction in HPCF.

<u>Inference</u>

H_0^1: From the contingency analysis given Table-33 it explains the rejection of the Null Hypothesis.

There is a significant positive effect of Group of Software Packages used 2 on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^2: From the contingency analysis given Table-40 one can reject the Null Hypothesis.

There is a significant positive effect of accessing facility on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^3: From the contingency analysis given Table-48 it reveals that the rejection of the Null Hypothesis.

There is a significant positive effect of usage of facility on customer satisfaction in HPCF-CMSD at level ($\alpha \leq 0.05$).

H_0^4: From the contingency analysis given Table-56 Explains the Rejection of the Null Hypothesis.

There is a significant positive effect of the personalization on customer satisfaction in HPCF-CMSD at level (α ≤ 0.05).

H_0^5: From the contingency analysis given Table-55 it reveals the Rejection of the Null Hypothesis.

There is a significant positive effect of the fulfillment of requirements on customer satisfaction in HPCF-CMSD at level (α ≤ 0.05).

5.5 Quantitative Analysis

Rating among the Over the attributes

The HPC rating and infrastructural rating is derived from the items of questionnaire which are given in 5 point scale has been treated as continuous measure and the analysis over the various characteristics have been carried out in this section.

The significant of attribute reveled a significant one-way analysis are organized in the following sub sections first infrastructural rating another for HPC rating.

Infrastructural rating

The analysis against the usage pattern showed significant infrastructural mean rating. Thus daily users are more satisfied by the infrastructural facility on the average over the weekly.

5.5.1 Job Submission

Table 87: Infrastructural Facility - Descriptive

					95% Confidence Interval for Mean		
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum

Daily	193	3.91	.484	.035	3.84	3.98	3
Weekly	200	3.77	.463	.033	3.71	3.84	3
Total	393	3.84	.477	.024	3.79	3.89	3

Table 88: Infrastructural Facility - ANOVA

	Sum of squares	df	Mean Square	F	Sig.
Between Groups	1.840	1	1.840	8.220	.004
Within Groups	87.501	391	.224		
Total	89.341	392			

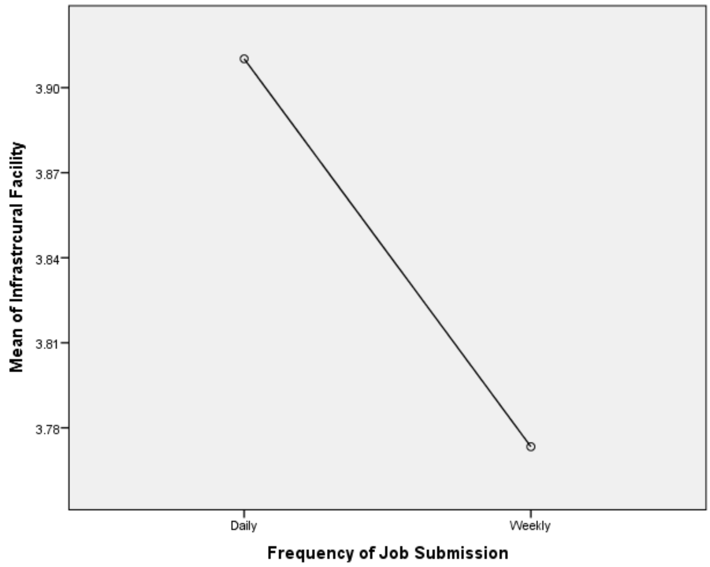
The above analysis exhibits statistically significant dependency (p-value =0.004) among usage pattern.

Daily usage users rated significantly high for Infrastructural Facility compare to weekly.

This may be because of the awareness of the Infrastructural facility by the frequent users than periodical users.

Workshops on Infrastructural facilities, training are expected to may enhance rating and will improve customer relationship management.

Means Plots of Frequency of Job Submission



5.5.2 HPC Users

Table 89: Infrastructural Facility Descriptive

Infrastructural Facility

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Daily	183	3.93	.477	.035	3.86	4.00	3	5
Weekly	174	3.75	.453	.034	3.69	3.82	3	5
Monthly	30	3.88	.543	.099	3.68	4.08	3	5
Rarely	6	3.56	.344	.141	3.19	3.92	3	4
Total	393	3.84	.477	.024	3.79	3.89	3	5

ANOVA

Infrastructural Facility

	Sum of Squares	df	Mean Square	F
Between Groups	3.239	3	1.080	4.877
Within Groups	86.102	389	.221	
Total	89.341	392		

The above analysis exhibits statistically significant dependency (p-value =0.002) among usage pattern.

Daily HPC users rated significantly high for Infrastructural Facility compare to weekly.

This may be because of the awareness of the Infrastructural facility by the frequent users than periodical users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will to the improve customer relationship management

Mean rating of Infrastructural Facility daily use of HPC is 3.93(0.035) which is statically significantly high than weekly mean rate 3.75(.034).

The rarely HPC users mean rate 3.56(0.141) is not statically low due to the higher standard error, whereas monthly users of HPC facility are statically in-significant in rating. This needs an investigation management strategy to enhance rating by weekly users.

Table 90: Dependent Variable: Infrastructural Facility

Multiple Comparisons

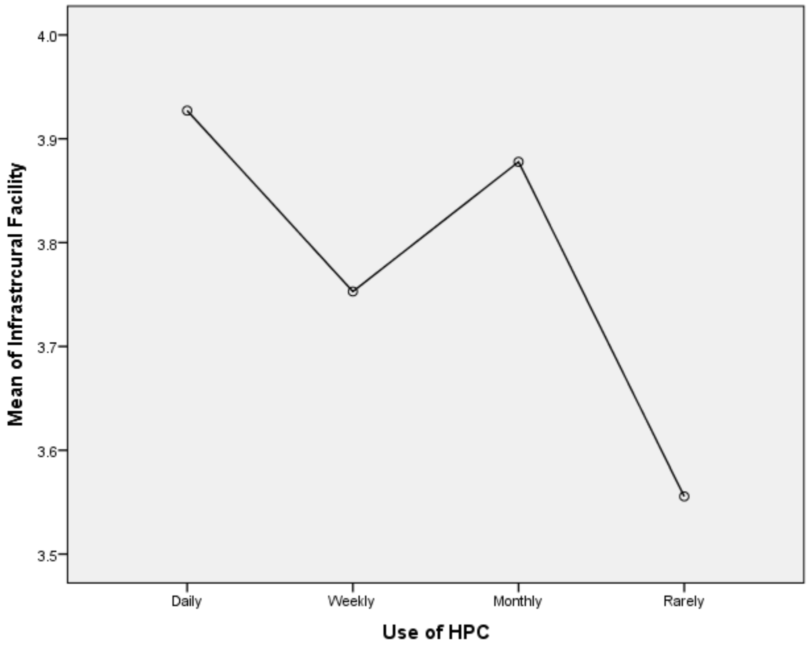
Dependent Variable: Infrastructural Facility

LSD

(I) Use of HPC	(J) Use of HPC	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Daily	Weekly	.174*	.050	.001	.08	.27
	Monthly	.049	.093	.595	-.13	.23
	Rarely	.372	.195	.058	-.01	.76
Weekly	Daily	-.174*	.050	.001	-.27	-.08
	Monthly	-.125	.093	.180	-.31	.06
	Rarely	.197	.195	.313	-.19	.58
Monthly	Daily	-.049	.093	.595	-.23	.13
	Weekly	.125	.093	.180	-.06	.31
	Rarely	.322	.210	.126	-.09	.74
Rarely	Daily	-.372	.195	.058	-.76	.01
	Weekly	-.197	.195	.313	-.58	.19
	Monthly	-.322	.210	.126	-.74	.09

*. The mean difference is significant at the 0.05 level.

Means Plot of Use of HPC



5.5.3 Type of application

Table 91: Infrastructural Facility

Descriptive								
Infrastructural Facility								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Parallel	234	3.89	.472	.031	3.83	3.95	3	5
Serial	159	3.77	.477	.038	3.69	3.84	3	5
Total	393	3.84	.477	.024	3.79	3.89	3	5

ANOVA					
Infrastructural Facility					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.433	1	1.433	6.372	.012
Within Groups	87.908	391	.225		

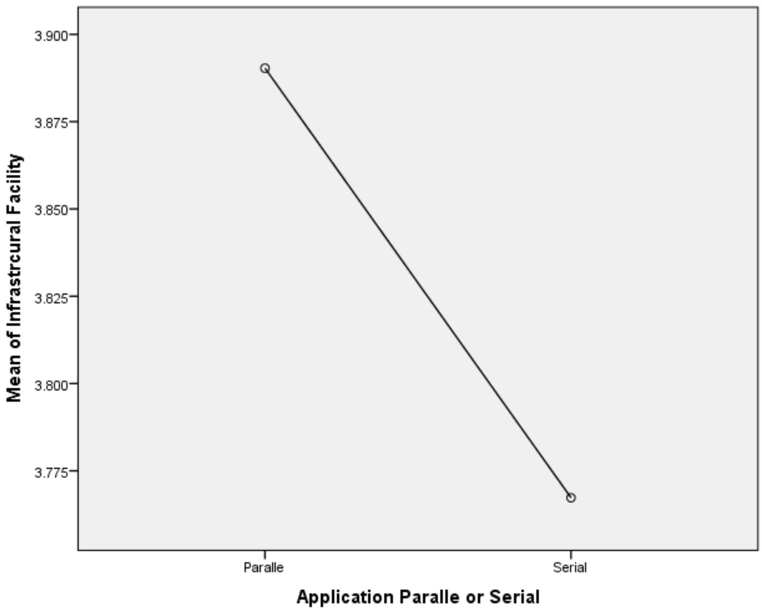
Total	89.341	392			

The above analysis exhibits statistically significant dependency (p-value 0.012) among usage pattern.

Parallel job users rated significantly high for Infrastructural Facility compare to Serial job users. This may be because of the awareness of the Infrastructural facility by the Parallel job users than serial job users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will improve customer relationship management

Means Plots of Application Parallel or Serial



5.5.4 HPC Rating

5.5.4.1 Field of study

Table 92: Field of study HPC Rating

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
School of Mathematics and Statistics	32	3.94	.180	.032	3.88	4.01	4	4

School of Physics	92	3.91	.313	.033	3.85	3.98	3	5
School of Chemistry	128	3.84	.302	.027	3.79	3.90	3	5
School of Life Sciences	108	3.83	.330	.032	3.76	3.89	3	5
School of Engineering Sciences and Technology	21	3.84	.299	.065	3.70	3.98	3	4
School of Economics	4	4.25	.000	.000	4.25	4.25	4	4
School of Computer and Information Sciences	8	3.88	.094	.033	3.80	3.95	4	4
Total	393	3.87	.304	.015	3.84	3.90	3	5

ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.222	6	.204	2.245	.038
Within Groups	35.019	386	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value =0.038) among usage pattern.

School of Economics users rated significantly high for HPC Rating compare to other school users. This may be because of the awareness of the HPC Rating by the School of Economics users than other school users.

Workshops on Infrastructural facilities, training is expected to may enhance rating and will improve customer relationship management

Mean rating of HPC Rating of School of Economics is 4.25(0.000) which is statically significantly high than other schools.

The School of Life Sciences users HPC Rating mean rate 3.89(0.032) is low

The users of the School of Economics are consistent.

Post Hoc Tests

Multiple Comparisons

Dependent Variable: HPC Rating

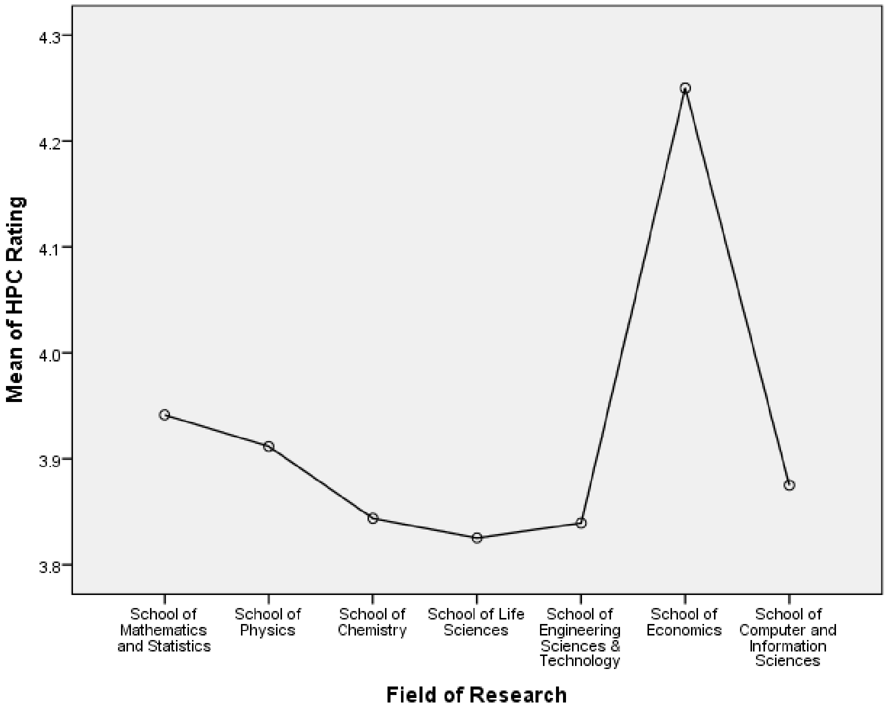
LSD

(I) Field of Research	(J) Field of Research	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
School of Mathematics and Statistics	School of Physics	.030	.062	.631	-.09	.15
	School of Chemistry	.098	.060	.102	-.02	.21
	School of Life Sciences	.116	.061	.056	.00	.24
	School of Engineering Sciences and Technology	.102	.085	.228	-.06	.27
	School of Economics	-.309	.160	.054	-.62	.01
	School of Computer and Information Sciences	.066	.119	.577	-.17	.30
School of Physics	School of Mathematics and Statistics	-.030	.062	.631	-.15	.09
	School of Chemistry	.068	.041	.100	-.01	.15
	School of Life Sciences	.086*	.043	.044	.00	.17
	School of Engineering Sciences and Technology	.072	.073	.321	-.07	.22
	School of Economics	-.338*	.154	.028	-.64	-.04
	School of Computer and Information Sciences	.037	.111	.741	-.18	.25
School of Chemistry	School of Mathematics and Statistics	-.098	.060	.102	-.21	.02
	School of Physics	-.068	.041	.100	-.15	.01
	School of Life Sciences	.019	.039	.638	-.06	.10
	School of Engineering Sciences and Technology	.004	.071	.950	-.13	.14
	School of Economics	-.406*	.153	.008	-.71	-.11
	School of Computer and Information Sciences	-.031	.110	.776	-.25	.18

School of Life Sciences	School of Mathematics and Statistics	-.116	.061	.056	-.24	.00
	School of Physics	-.086*	.043	.044	-.17	.00
	School of Chemistry	-.019	.039	.638	-.10	.06
	School of Engineering Sciences and Technology	-.014	.072	.845	-.16	.13
	School of Economics	-.425*	.153	.006	-.73	-.12
	School of Computer and Information Sciences	-.050	.110	.652	-.27	.17
School of Engineering Sciences and Technology	School of Mathematics and Statistics	-.102	.085	.228	-.27	.06
	School of Physics	-.072	.073	.321	-.22	.07
	School of Chemistry	-.004	.071	.950	-.14	.13
	School of Life Sciences	.014	.072	.845	-.13	.16
	School of Economics	-.411*	.164	.013	-.73	-.09
	School of Computer and Information Sciences	-.036	.125	.775	-.28	.21
School of Economics	School of Mathematics and Statistics	.309	.160	.054	-.01	.62
	School of Physics	.338*	.154	.028	.04	.64
	School of Chemistry	.406*	.153	.008	.11	.71
	School of Life Sciences	.425*	.153	.006	.12	.73
	School of Engineering Sciences and Technology	.411*	.164	.013	.09	.73
	School of Computer and Information Sciences	.375*	.184	.043	.01	.74
School of Computer and Information Sciences	School of Mathematics and Statistics	-.066	.119	.577	-.30	.17
	School of Physics	-.037	.111	.741	-.25	.18
	School of Chemistry	.031	.110	.776	-.18	.25
	School of Life Sciences	.050	.110	.652	-.17	.27
	School of Engineering Sciences and Technology	.036	.125	.775	-.21	.28
	School of Economics	-.375*	.184	.043	-.74	-.01

*. The mean difference is significant at the 0.05 level.

Means Plots of Field of Research



5.5.4.2 Usage period

Table 93: HPC Rating Usage period

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
2-4 Years	8	4.16	.129	.046	4.05	4.26	4	4
> 4 Years	385	3.86	.304	.015	3.83	3.89	3	5
Total	393	3.87	.304	.015	3.84	3.90	3	5

ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.683	1	.683	7.510	.006
Within Groups	35.558	391	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value 0.006) among usage pattern.

Means Plots of HPC Usage Period

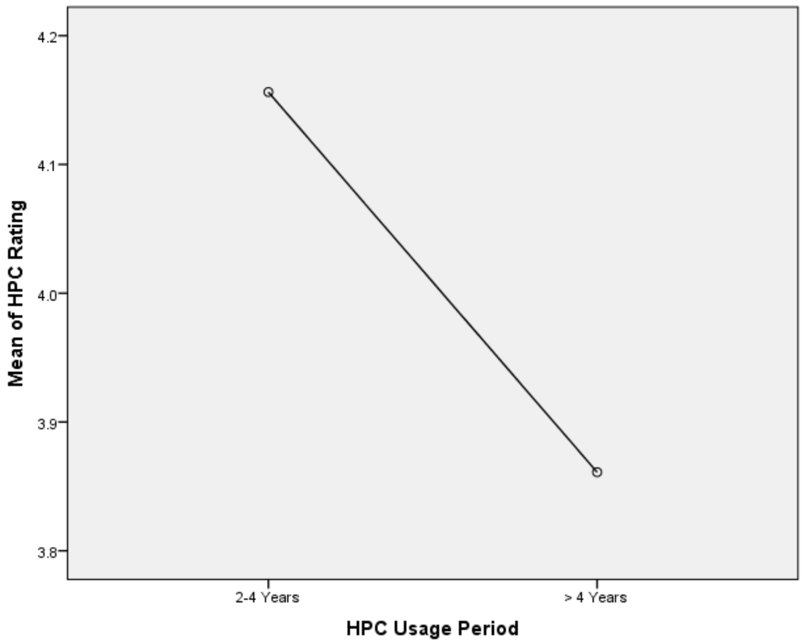


Table 94: HPC Rating Organization

Descriptive								
HPC Rating								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Funding Agency	126	3.81	.308	.027	3.76	3.87	3	5
University - HPC	267	3.89	.300	.018	3.86	3.93	3	5
Total	393	3.87	.304	.015	3.84	3.90	3	5

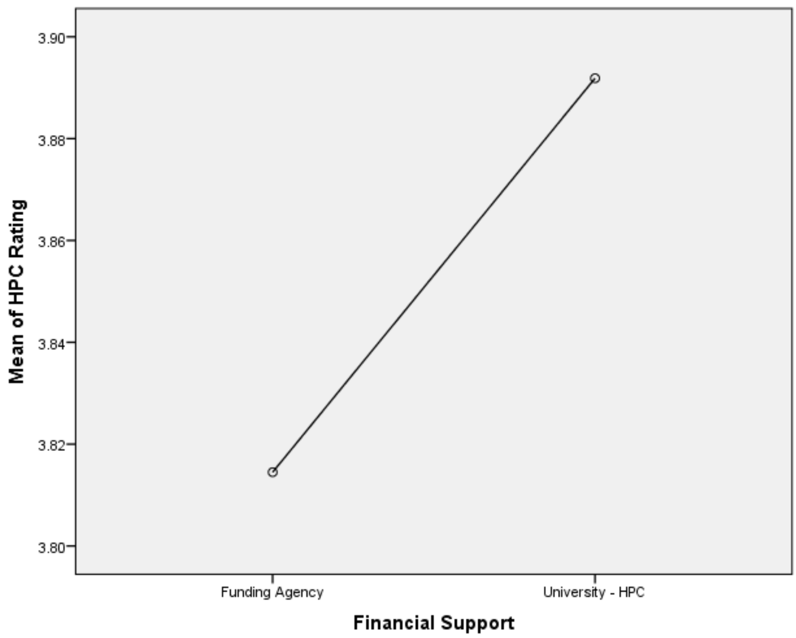
ANOVA

HPC Rating

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.512	1	.512	5.608	.018
Within Groups	35.728	391	.091		
Total	36.241	392			

The above analysis exhibits statistically significant dependency (p-value 0.018) among usage pattern.

Means Plots of Financial Support



3.90
3.88
3.86
3.84
3.82
3.80
Mean of HPC Rating
Funding Agency
University - HPC
Financial Support

5.6 Summary

The data which is organized in SPSS has been analyzed mainly frequency analysis, contingency analysis and analysis of variance by using SPSS scarping language.

Some of the observations are as follows:

The significant association has been revealed most of the cases the particular users like faculty, scientists looks better and safety storage. While the researchers like research scholar and research assistants for fixed period looks more enhanced RAM facility for efficient computational power.

Managing security and storage issues are exposed to give better Customer Relationship. However enhance the RAM for better customer relation to the fixed period users like research scholars can be addressed with the current day technology by adopting the cloud solutions.

The infrastructural facility rating to improve HPC Center need conduct awareness programmes to the users. Give training in the related felids to convert the serial job users to the parallel job users so they can use HPC very optimally.

The user are requires the guidance to use the HPC facility, so that they can get the maximum benefits of the systems. It also gives raise to the HPC rating.

Workshops on Infrastructural facilities, training are expected to enhance rating and will improve customer relationship management.

6. Findings Suggestions and Conclusions

Based on the analysis of primary data the following findings were made. Certain suggestions were also given for better CRM practices at HPC.

6.1 Findings and Suggestions

- The research scholars of chemistry and faculty members of life sciences constitute the majority of users of HPC.

  The HPC administration should conduct awareness seminars/workshops and hands on sessions to all the students, faculty and researchers of the University.

- The number of software packages used by the school of chemistry users i.e. research scholars, faculty and students is higher than other school/departments.

  The HPC management has to provide the information, as to how to use packages and offer online help in order to increase the user participation to improve the users' satisfaction levels.

- The research scholars develop an interest about the HPC facility and its usage after a considerable period of time.

  To attract new users, the HPC management needs to publish the details of the facility and the advantages of HPC to the researchers.

- Researchers rated the "Security of the data" as moderate. In reality the data set are highly valuable for their research activity.

  HPC needs to give higher priority to "security to data" to get the confidence of the users and develop a good relationship with the researchers.

- The internal users (University community) are using more of these HPC facilities whereas the number of external users using the facility is very less. HPC needs to increase/develop the skills and network connectivity (bandwidth) support, virtual guidance to support remotely by email/online. It will help to develop the relationship with customers by positively addressing the issues of the users and providing the user friendly environment.

- University of Hyderabad users are using more "serial" jobs than the remote login users. The real utilization of the HPC can be achieved by controlling the serial jobs. We can derive the objective of the HPC facility.

- In High Performance Computing centers a Management Policy can be drafted for "Additional Disk Space", which not only satisfies the faculty but also works as a revenue strategy for sustainable maintenance. While Research Scholars want to enhance the RAM it will bring goodwill from the Research Scholars. Periodic upgrading of system also is one of the ways out.

- The "Frequency of Job Submission" is more by Parallel users in (once or twice in a week) and Serial by daily users at University of Hyderabad High Performance Computing Facility. The serial jobs need to be reduced to meet the objective of the HPC.

- Periodic conducting of High Performance Computing Orientation program in "Job Submission Process (JSP)" for the student community and customized workshop on "Job Submission Process" for the Research Scholars and Faculty will enhance the utility.

- Deploying of third party "data security" system may integrate the processing and installing of "additional disk space". Conducting the awareness program of the third party security product by the High Performance Computing users will enhance the dependence on High Performance Computing facility.

- HPC users like faculty, scientists look for better safe data storage. While the researchers like research scholars and research assistants (working for a fixed period) look for more enhanced RAM facility for efficient computational power.

- The number of outside users using HPC facility is very less. HPC facility needs to increase/develop the skills of network connectivity support, virtual guidance (to support remotely by email/online).

- The "Frequency of Job Submission" by the researchers of School of Chemistry is high among daily users while the faculty of life science number is high for weekly job submission at University of Hyderabad High Performance Computing Facility.

- Managing security and storage issues are expected to give promote Customer Relationship. However enhance the RAM for better customer relation (to the fixed period users like research scholars) can be addressed with the current day technology by adopting the cloud solutions.

- The "Frequency of Job Submissions" by the faculty ("Group of Software Packages users) is more for weekly job submission at University of Hyderabad High Performance Computing Facility.

- Two thirds of the users are in need of continuing resources requiring the 24x7 availability. The remaining one third of the users badly need the technical support and application support. If these issues are properly addressed through e-CRM strategies it is expected that the user satisfaction will enhance.

- Only 30% of the users are provided with project planning and implementation support. It needs to be improved by the HPC facility management. 50% of the users are provided with the security for their data. This issue needs to be addressed to improve the user satisfaction. On third of the users experienced system crashing. 25% of the users felt that the technical support is not adequate.

- The daily users appreciated the job submission process, whereas others have expressed less satisfaction, which indicates that job submission processes are highly technical which needs persistent efforts.

- A frame work embedded in e-CRM that helps in simplifying in job submission process will enhance satisfaction levels.

- An appropriate middleware management technology can be provided for the users to enhance the performance of the system.

- The effective utilization of HPC involves knowledge about the systems, procedures like "job submission process", "data storage" utilities and access rights etc. A frame work with simplified user-friendly environment embedded in e-CRM with suggestive alternates options needed for the applications of specific users (to provide required job submission script files) will enhance user satisfaction at all levels as well as throughput and utility factors.

- The HPC facility should improve the relationship with the users (customer) by addressing the issues. This can be achieved by providing the best possible hardware and software and most importantly skilled Human resources.

- A Graphical user interface for job submission process and associated options should be embedded in e-CRM to enhance the HPC user satisfaction.
- Enabling effective web services facilities by coupling with authorization, authenticating by protecting privileges and support will create an additional dimension to e-CRM to access location independent services.

- A personalized graphical user interface, integrating user group information, year of registration and application specific details of users will enhance the user satisfaction, usage levels as well as throughput of HPC.

- The HPC facility at Center for modeling and design, University of Hyderabad can use the network facility to submit the jobs remotely, export and import the data and output over the network. Many users submitted their research papers quoting the work done using the HPC at CMSD, University of Hyderabad. Providing the virtual guidance, online help with e-CRM tools like touch points will help the remote users. All HPC facilities need to regularly update to the latest technology to facilitate solutions to their users, and build good customer relationship management.

6.2 Limitations of the Study

- The study is confined to the CMSD HPC environment of University of Hyderabad. The generalization of results needs replication of similar studies, to avoid the risk of bias.
- The present study is restricted to a snapshot, of users and HPC environment and processes.
- The study is not considered the cost and environmental friendliness factors.

6.3 Scope for further studies

The objective of this research is to study the impact factors of the e-CRM performance from customers and HPC facility service perspectives.

- The study pertaining to the interface e-CRM framework has been carried out offline, can be made online and integrate to the e-CRM on customer satisfaction system by deploying an agent for carrying out the analysis, inference arriving.
- This can be extended to the users and usage of the Cloud Computing.
- Can make more user friendly applications or by developing the portal for accessing by the user.

6.4 Conclusions:

The High Performance Computing (HPC) serves the needs of researchers across various disciplines of the sciences, biochemistry, physics, geology, Chemistry, Computer Science, Aeronautics, high power, highly complex computing applications and environments that analyze massive amounts of data and require massive funding from research and science foundations.

The benefits of high performance computing with e-CRM can result in top line growth and bottom line savings. More importantly, HPC-eCRM enables a competitive advantage in that institutions have greater flexibility to more quickly respond to external opportunities thanks to more detailed risk analyses and in-depth predictive customer insights among other benefits.

As this is a first of its kind to the best of our knowledge the concept of e-CRM framework interface module is the subject matter of study is executed. There was no specific study in the context of University setup High Performance Computing Facilities.

- The e-CRM influence effectively extracts customer requirements, needs and psychological aspects for rating as well as performance analysis of a HPC facility.
- The e-CRM enhances the confidence levels of the users in utilizing the overall services of the HPC facility.
- The e-CRM assists in planning, performing and enhancing the effectiveness of HPC facility.
- The e-CRM can be made more effective by integrating with the HPC facility for cost effective planning control maintenance.

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Appendix - I

Questionnaire

I E A VINOD KUMAR, perusing my Ph.D in Management studies, University of Hyderabad. My Topic is "The Impact of Electronic Customer Relationship Management (e-CRM) on Customer Satisfaction: A study of High Performance Computing (HPC) Facility at University of Hyderabad". I would appreciate, if you can fill the following questions. The data is kept confidential and used purely for academic purpose.

Name	
Designation	
Institution Name	
Email address	
Contact No	Code ( )

1. Specify your field of research?

2. Specify the scientific supercomputing applications do you run?

    a)
    b)
    c)
    d)
    e)

3. Where are you registered for using HPC facility?

4. When did you register with University of Hyderabad?

5. From where do you use the HPC facilities?

    1. Lab
    2. Office on Campus
    3. HPC Center
    4. Home

6. Could you carry out your work/research without the University HPC facilities?

    1. Yes
    2. No

7. What operating system do you use on your (home or work) computer to access the High Performance Computing Facilities (HPC)
    1. Linux
    2. AIX

8. Do you use the HPC facilities for

    1. Batch Jobs
    2. Interactive Jobs
    3. Both

9. Frequency of Jobs Submitting?

    1. Daily
    2. Weekly

10. How often do you use the University High Performance Computing (HPC) Facilities?

    1. Daily
    2. Weekly
    3. Monthly
    4. Rarely

11. The Job Submission process is:

    ☐ Excellent ☐ Satisfactory ☐ Moderate ☐ Complex

12. HPC Usage

    a. Period: ☐ < ☐ 1–2years ☐ 2 – 4years ☐ 4yrs and above

13. Number of jobs submitted during the above period?

14. Cumulative System Usage in % Days ☐ Hrs ☐ Mts ☐

15. The Nature of the Jobs.

    a. Parallelizable
    b. Serial
    c. Both
    d. Any other

16. The Security for job.

    1. Good 2. Excellent

17. Security for the Data.
    1 Good 2. Excellent

18. The Financial Support
    a. Funding Agency
    b. University -HPC

19. Rating of HPC(University of Hyderabad)

	1	2	3	4	5
a. Academic	☐	☐	☐	☐	☐
b. Network Connectivity	☐	☐	☐	☐	☐
c. Training	☐	☐	☐	☐	☐
d. Technical Support	☐	☐	☐	☐	☐
e. User Interaction	☐	☐	☐	☐	☐
f. Facility	☐	☐	☐	☐	☐
g. Packages	☐	☐	☐	☐	☐
h. Security	☐	☐	☐	☐	☐
i. Infrastructure Support					

20. System Infrastructure Facility.

1) Memory	☐	☐	☐	☐	☐
2) Storage space	☐	☐	☐	☐	☐
3) Data Base	☐	☐	☐	☐	☐

RANK: 1-low … 5-highest

21. How long are your runs?

This refers to the kind of resources you currently use and a typical single run.
Please select all that apply.

☐ A run takes a few minutes only

☐ No longer than 4 hours

☐ Between 4 and 48 hours

- ☐ 2-4 days
- ☐ Very long, weeks or even months

22. Are your applications trivially parallelizing?

    If you run several applications and they are different with respect to Parallelization, please select all that apply.

    - ☐ Yes, our applications can be run on hundreds of CPUs
    - ☐ No, our applications are parallelized, but there is a scaling limit
    - ☐ we run mainly in a serial mode

23. Where do you currently get your supercomputing resources?

    Please select all that apply.

    - ☐ We use our own in-house resources.
    - ☐ We use (or purchase time from) scientific computing centers.
    - ☐ We purchase resources from commercial companies.

    If other than in-house, which specific sources do you use?

24. Do you use the computer resources continuously or time to time, project by project?

    a. We need resources continuously

       A.15days B. 1Month C. > Month

    b. We use resources on demand, depending on the project.

25. What kind of support would you need?

    - ☐ Technical support (passwords, quotas, etc.)?
    - ☐ Support on use of applications?
    - ☐ Support on planning and implementation of computational projects

    Other kind of support, what?

26. How important is security of your data to you?

    i. It is important; however sharing resources with others is OK. The security level provided by the operating system is enough.

ii. Security is very important. We need a special solution even if at an additional cost.

iii. What are your specific security needs, if any?

27. Based on your experience, are any of the following problems relevant to you as a user of high performance computing resources?

Please select all that apply

i. Substandard system performance
ii. Unreliability of the system (crashes)
iii. Long queuing time
iv. Substandard or missing technical support
v. Long support response time
vi. Missing computational software or development tools
vii. Strict disk space and CPU quotas
viii. Too much time spent on support issues like quotas and permissions
ix. Something else?(pls. mention)

28. What are the services you would like to see in a supercomputing resource you use?
1.
2.
3.
4.
5.

29. The Need for HPC?(Pls write your comment briefly)

30. List Rank order (descending Order) the HPC.
1) 2) 3)

31. Suggestions for improving the services further.

We appreciate your contribution!
Comments on this questionnaire are most welcome.

Can you please recommend us to contact.

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Synopsis of the

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DOCTOR OF PHILOSOPHY
IN
MANAGEMENT

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