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Impact and Significance of Electronic Information Resources among Aerospace Scientists, Engineers and Technologists of Bangalore: A Research Survey

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ABSTRACT: Aviation is one of the most significant technological marvels of our time and empowers the nation with strength. It's a major tool for economic development and has a significant role in national security and international relations. Aerospace Engineering is the application of advanced science and technology for the design and development of flight vehicles. Originally called Aeronautical Engineering dealing solely with aircraft, the broader term "Aerospace Engineering" has replaced the former in most usage, as flight technology advanced to include aircraft operating the earth's atmosphere. In this Information Explosion age, it is practically impossible for an aerospace scientist or engineer to carry out his research work without embracing the network and Internet technologies. They greatly depend upon these electronic innovation tools for accessing electronic information resources in the form of e-journals related to aerospace engineering right at the desktops. Now, it is absolutely clear that use of electronic media to support scientific communication has undoubtedly been one of the paradigm shifts in the practice of science in this era. With the coming of e-resources, there has been a significant transformation by which scholarly information is disseminated throughout the world. In fact, the arrival of e-journals has greatly influenced the way a scientist or an engineer seeks this information, acquires it and then uses it effectively. Today Governments, R&D institutions and Universities invest substantial sums of money for providing scholars with the digital literature they need for their research work with the intention that improved access to electronic information resources will lead to increasing scholarly productivity. The extent of publications available online combined with easier access has tremendously improved scholars' ability to keep abreast in their field, and perhaps inspire new ideas and ultimately enhance the quality of their work. The use pattern of electronic information resources is same for scientists and engineers irrespective of their disciplines. But, aerospace scientists and engineers have an advantage as they are well exposed to the electronic environment and IT due to the nature of their work itself. The use of electronic information resources is highly expected from them particularly as an integrated information system to their learning and working environment. The author has in this research study attempted to study the impact of electronic information resources, amongst the Indian Aerospace Scientists, Engineers and Technologists. The geographical boundary of this study is restricted to the 16 prominent aerospace organizations of Bangalore. The city of Bangalore is rightly called the 'Aerospace Hub of the Country'.

KEYWORDS: Electronic Information Resources, Use Patterns, Aerospace Scientists and Engineers, Internet technologies, Information Explosion, Scholarly Information, Scientific Communication.

I. INTRODUCTION

Aviation is one of the most significant technological marvels of our time and empowers the nation with strength. It is a major tool for economic development and has a significant role in national security and international relations. Aerospace engineering is the application of advanced science and technology for the design and development of flight vehicles. These include aircraft, spacecraft, missiles and rockets. An aerospace engineer develops new technologies for

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control, navigation and propulsion that will lead to future milestones in the history of flight. Originally called aeronautical engineering dealing solely with aircraft, the broader term "aerospace engineering" has replaced the former in most usage, as flight technology advanced to include craft operating outside the earth's atmosphere. In analogy with "aeronautical engineering", the branch is sometimes referred to as astronautical engineering, although this term usually only concerns craft which operate in outer space. Aerospace engineering comprises several disciplines: aerodynamics, flight mechanics and control, avionics, navigation, propulsion, structures, materials, and manufacturing, etc.

In this information explosion age, it is practically impossible for an aerospace scientist or engineer to carry out his research work without embracing the network and Internet technologies. They greatly depend upon these electronic innovation tools for accessing electronic information resources in the form of e-journals related to aerospace engineering right at their desktops. In fact, many of the scientists in today's R&D organizations have the unique privilege of downloading full-text e-journals right at their desktops through their Organization's e-Conglomerate. It is absolutely clear that the use of electronic media to support scientific communication has undoubtedly been one of the paradigm shifts in the practice of science in this era. For a research scientist, today, with access to the Internet, working across continents and in different time zones and keeping in touch with his peers has indeed become a reality due to the exponential growth of the telecommunication infrastructure that the world has witnessed. Most surprisingly, all this happens with very marginal costs of communication.

With the coming of e-resources, there has been a significant transformation by which scholarly information is disseminated throughout the world. In fact, the arrival of e-journals has greatly affected the way a scientist or an engineer seeks this information, acquires it and then uses it effectively.

With this radical shift in scholarly research, it is not surprising that the role of the librarian as an 'information provider' has dramatically changed. With constant advances in technology, the library and the librarian need to adjust by 'embracing the electronic technology' to meet the constant fluctuation and demands in the user's information seeking behaviour and needs.

Today, scientists and engineers use electronic resources because of quick, easy access, and convenience. Also, very little effort is required to retrieve information from these e-resources.

Scholarly communication is very rapidly evolving. The usage trend is leaning more and more towards electronic formats. In many of the scientific areas, it is also observed that the electronic version of scientific publications is being read almost as often as the printed journals. If this trend continues, many authors feel that in the years to come the print versions of scientific publications will more or less disappear. It is very clear that the World Wide Web has very largely facilitated and propelled the emergence of these electronic resources.

It is important to note that the scientists and engineers in aerospace organizations are currently working on projects, which are of strategic importance to this country. These scientists largely depend on rapid collection of information from various 'electronic information resources'

II. NEED FOR ELECTRONIC INFORMATION RESOURCES AND SERVICES AMONG THE SCIENTISTS AND ENGINEERS

During the late 1980's and early 1990's many new information technologies arose that revolutionized the way in which people searched for and gathered information. More and more publications began to profile the impact that new electronic resources had on different populations. The coming of the Internet itself was the most fundamental shift since Gutenberg's invention of the printing press, Gleeson [1].

Somewhere between 1994 and 1996 there was a profound shift in electronic resource usage by scientists. The shift could be attributed to the increase in popularity and usability of the Internet itself as well as the resources it contained. Curtis;Weller and Hurd [2] opine that the increase in the use of the electronic information resources was attributed to the availability of more and better electronic resources, desktop access through networked workstations, and user-friendly interface design.

With the coming of the twenty-first century, successful storage and retrieval of the exponentially growing body of scientific information quickly became dependent upon the Internet and World Wide Web. The way in which scientists seek information to support teaching, research and creative activities is changing as new technologies and information delivery systems emerge, Brown [3]. Consequently, the traditional model of scientific communication proposed by

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Garvey and Griffith [4], states that information is primarily disseminated through, and subsequently becomes most highly valued when printed in, refereed journals, is being challenged. Any early model of electronic communication proposed by Lancaster [5], and modernized by Hurd et al., [6], bypasses printed journals, indexes, and abstracting tools and suggests that scientific information dissemination will eventually be purely electronic. In the light of the escalating cost to libraries for purchasing and archiving printed scholarly journals, electronic journals may prove to become the only alternative for maintaining an active platform for scientific scholarly communication, Tenopir and King [7], Odlyzko [8] and Walker [9].

Electronic information services are obviously an upcoming and endearing activity among all the scientists and engineers irrespective of their disciplines and work environment. The on-line access services and the Internet services are the two of the most popular library services in electronic formats today.

Today, scientists have adopted electronic journals because of quick, convenient access from their desktops and the little effort required to retrieve information from them. It's quite obvious that electronic journals are a resource of convenience and therefore will be quickly adopted by most of the scholarly groups.

II. AEROSPACE AND DEFENCE RESOURCES (AERADE) PIONEERING INITIATIVES IN PROMOTING THE USE OF AEROSPACE ELECTRONIC INFORMATION RESOURCES

The Aerospace Information Management – UK (AIM-UK) project –found compelling evidence of ‘under-utilization’ of ‘electronic information resources’ by the aerospace scientists and engineers. It recommended a number of initiatives to raise awareness and improve access to useful electronic information resources, and to reduce the threat of ‘information overload’. In particular, there was a call to establish an Internet gateway and portal to the aerospace and defense community that would act as a “jumping-off-point” for effective exploration and retrieval of information on the World Wide Web. Launched in November, 1999, AERADE is specifically designed to meet this need. It is an initiative developed by the Cranfield University to enable aerospace and defense experts to find relevant information on the Internet. Today, the reports archive is a historical collection of over 10,000 significant technical papers and reports produced by the Aeronautic Research Council (ARC) and the National Advisory Committee for Aeronautics (NACA), Hanley; Harrington and Blagden, [10].

III. DISTINGUISHING SCIENTISTS AND ENGINEERS

As the user community under study is aerospace scientists and engineers, an attempt is made here to distinguish them.

There are authors like Allen [11], Citro and Kalton [12], Pinelli [13], and Latour [14] who have defined the scope of activity of engineers and scientists. For instance, Citro and Kalton [12], describe differences based on analyses of tasks, job descriptions, education, and self-identification. Their analysis indicated that even using multiple indicators did not reduce the error in classifications into engineering and science. Pinelli [13], suspects that the increasing bureaucratization of these professions makes it more difficult to accurately differentiate them. Latour [14] used the term “technoscience” to describe the relationship between engineering and science. Using a network actor perspective, he described the daily activities of both scientists and engineers.

When one examines engineers and scientists over the course of their careers, it becomes increasingly difficult to distinguish them. When each does those activities that we traditionally consider the activities of engineers and scientists, each group appears to behave quite differently. Yet many of their activities, such as management, are the same. Contradictions based on the various differences between the groups contribute to the misunderstanding that engineers are the same as scientists.

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Most Engineers	Most Scientists
Do development, design or applications work	Do research, basic or applied
Apply scientific knowledge	Seek new knowledge
Have engineering degree	Have science degree
Recognize managerial authority	Respect "colleague" authority
Want assignments to good, challenging projects	Want freedom to select their own projects
Like a company with a good record of engineering accomplishment	Like a company with a reputation for scientific advancement
Are hardware oriented	Are software oriented
Dislike preparing talks and publications	Insist on freedom to publish their work
<u>Are company oriented</u> (i.e. committed to a variety of work areas, tasks, positions)	<u>Are career oriented</u> (i.e. committed to limited kinds of work areas, tasks, positions)
Dislike ambiguous, uncertain situations Are interested in processes, results, realizations	Can work effectively with ambiguity, uncertainty Are interested in concepts, meanings, abstractions
Believe in equalitarian group practices	Believe in authoritarian group practices
Expect to be faced with work schedules, deadlines, constrained resources	Abhor schedules, believe schedules should be self-determined, desire autonomy

**Table – 1; Differences Between Engineers and Scientists,
Source: Peake, [15]**

IV. USE PATTERNS OF ELECTRONIC INFORMATION RESOURCES

Several studies on the influence of the use of electronic information resources on scholarly work have indicated that the use of electronic literature has improved their work considerably in several ways.

Today Governments, R&D institutions and Universities invest substantial sums of money for providing scholars with the digital literature they need for their research work with the intention that improved access to electronic information resources will lead to increasing scholarly productivity. The transformation of the physical library to the virtual library probably saves time, since one can access publications from one's desktop. The extent of publications available online combined with easier access has tremendously improved scholars' ability to keep abreast in their field, and perhaps inspire new ideas and ultimately enhance the quality of their work.

Several studies on the perceived influence of e-resources use on scholarly productivity have indicated that factors like: (a) Easier to find material, (b) Easier to get hold of material, (c) Extended range of material available electronically, (d) Easier to keep updated in one's field of research, (e) Improved quality of work, (f) Inspired new ideas, (g) Greatly saved working time, (h) Reduced time browsing in libraries, (i) multi-user access, fast access, (j) 24 hour access, (k) Available before print, (l) Multiple file formats for downloading and storing (PDF, RTF, DOC, HTML etc..), (m) enhanced access and visibility to scientific papers, (n) Keeps current about global R&D etc. has indicated that the use of electronic resources has considerably influenced the quality of work of the scholars and inspired new ideas to some extent.

What do the trends reflect? Since their birth in the 17th century, 'Scientific scholarly journals have become the most used type of publication and, for most fields of science, the most inevitable, and the single most channel of communication', Tenopir and King [7].

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Over the last 40 years, numerous studies have indicated that journals are extensively read; the information they contain is extremely useful for research, teaching and life-long learning; and the information is valuable in terms of the favourable outcomes from its use. All of these factors have remained stable over the years.

V. CSIR-NATIONAL AEROSPACE LABORATORIES, BANGALORE

NAL is a constituent Institution under the Council of Scientific and Industrial Research of India. NAL is a high technology oriented institution concentrating on advanced topics in the aerospace and related disciplines. Originally started as National Aeronautical Laboratory, it was renamed National Aerospace Laboratories to reflect its major involvement in the Indian space programme, its multidisciplinary activities and global positioning. It is India's only civilian aerospace laboratory with a high level of competence. The expertise of its scientists is globally acknowledged. NAL has some very sophisticated test facilities which are the best in the country and comparable to those abroad. The 1.2 m Trisonic Tunnel Complex, Full Scale Fatigue Facility, Acoustic Test Facility, Engineer-in-Loop Facility, Composite Structure Facilities, Advanced Turbomachinery and Combustion Laboratories, Failure Analysis Laboratory and Electromagnetic Laboratory are among these. All these manned by specialized teams provide value added inputs to various Indian aerospace programmes. Its main Mandate and Mission are: (a) Development of aerospace technologies with a strong science content and with a view to their practical application to the design and construction of flight vehicles, (b) NAL is also required to use its aerospace technology base for general industrial applications. NAL is the harbinger of civil aviation design and development activities in India. NAL-designed HANSA trainer aircraft is flying in different flying clubs in India and is all set to reach overseas market. The light transport aircraft, SARAS, is undergoing flight testing and is designed to meet a critical need in the civil aviation segment. In a nutshell, 'Technology' would be NAL's core engine for the future. NAL will make special efforts to identify, develop and market spin-off technologies.

VII. OBJECTIVES OF THE STUDY

The main objectives relating to the study on use patterns of electronic information resources by the aerospace scientists and engineers in Bangalore are as follows:

- To determine the types of e-resources, information requirements and needs.
- To ascertain the patterns of electronic information resources used.
- To identify the various channels through which information is accessed.
- To find the reasons for specific patterns to be noticed in the electronic information use.
- To identify the factors motivating electronic information use.
- To examine the different factors which facilitate the use of information / e-resources / services use.
- To understand the information gathering behavior.
- To identify any constraints faced by the scientists while locating / using / searching e-information in libraries.

VIII. HYPOTHESES

- The use of e-resources is more than the printed resources among aerospace scientists.
- Instantly available e-resources heavily motivate the aerospace scientists and engineers.
- The electronic information resource needs of the scientists working in the aerospace organizations in Bangalore are homogeneous in nature.
- Lack of adequate training to the scientists for access and use of electronic information resources for scientific research is one of the inevitable barriers and difficulties faced while seeking information.

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IX. MATERIALS AND METHODS

This research survey is restricted to the selected 16 prominent aerospace organizations in Bangalore. A total number of 650 survey questionnaires were distributed amongst the aerospace scientists and engineers belonging to these 16 aerospace organizations. A total number of 612 questionnaires were received back finally 583 (89.7%) were selected for the study which were found suitable for the study.

A survey questionnaire has been used to conduct this research study. The total population size of this research study is restricted to the 1220 aerospace scientists and engineers in Bangalore. The distribution of Source Data is indicated in *Table 1*. Random sampling technique has been used for selection of the sample size.

Table-1: Distribution of Source Data (Sample Size)

Sl. No.	Organizations	No. of Questionnaires distributed	No. of Questionnaires received	No. of usable questionnaires usable
1.	ADA	67	63	58
2.	AFTC	19	16	15
3.	ADE	14	12	12
4.	ASTE	33	30	29
5.	CABS	16	15	14
6.	CEMILAC	33	30	29
7.	C-MMACS	8	6	6
8.	DARE	11	9	9
9.	LRDE	5	3	2
10.	GTRE	24	22	21
11.	HAL	144	140	134
12.	IAM	40	36	33
13.	ISRO-ISTRAC	25	24	22
14.	IISc	38	37	34
15.	JNCASR	5	3	1
16.	NAL	168	166	164
Total		650	612	583 (89.7%)

Geographical Boundary of the Study (16 Prominent Aerospace Organizations of Bangalore, INDIA).

Key: ADA=Aeronautical Development Agency, AFTC=Air Force Technical College, ADE=Aeronautical Development Establishment, ASTE=Aircraft Systems Testing Establishment, CABS=Centre for Airborne Systems, CEMILAC=Centre for Military Airworthiness and Certification, C-MMACS=Centre for Mathematical Modeling and Computer Simulation, DARE=Defense Avionics Research Establishment, LRDE=Electronics and Radar Development Establishment, GTRE=Gas Turbine Research Establishment, HAL=Hindustan Aeronautics Limited, IAM=Institute of Aerospace Medicine, ISRO-ISTRAC=Indian Space Research Organization, IISc=Indian Institute of Science, JNCASR=Jawaharlal Nehru Centre for Advanced Scientific Research, NAL=National Aerospace Laboratories.

X. PROFILE OF RESPONDENTS: CATEGORY WISE DISTRIBUTION

As part of the research survey, the investigator divided the whole population of the study into two major categories: namely, aerospace scientists and engineers. It may be seen from table 2, that out of the 583 respondents, 295 (50.6%) are aerospace scientists and the remaining 288(49.4%) are aerospace engineers.

Out of the 16 organizations examined, NAL has the largest number of aerospace scientists (120) and engineers (44), amounting to a total of 164(28.1%). HAL follows next with a total of 134 aerospace scientists (3) and engineers (131) scoring 134(23%). LRDE and JNCASR represent very low numbers indicating (2 scientists and no engineers, (0.3%)) and (scientists 1; 0 engineers, (0.2%)) respectively.

Chi Square: The χ^2 test indicates that the category wise distribution of the 583 respondents and the different types of aerospace organizations have significant association (Chi-Square=278.811, P = 0.000).

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Table-2: Category-Wise Distribution of the Sample

Sl. No.	Organizations	Categories		Organization Wise, Total No. of Respondents	% of Total Sample
		Aerospace Scientist	Aerospace Engineer		
1	ADA	39	19	58	9.9
2	AFTC	0	15	15	2.6
3	ADE	12	0	12	2.1
4	ASTE	2	27	29	5.0
5	CABS	13	1	14	2.4
6	CEMILAC	26	3	29	5.0
7	C-MMACS	2	4	6	1.0
8	DARE	7	2	9	1.5
9	LRDE	2	0	2	0.3
10	GTRE	12	9	21	3.6
11	HAL	3	131	134	23.0
12	IAM	30	3	33	5.7
13	ISRO-ISTRAC	5	17	22	3.8
14	IISc	21	13	34	5.8
15	JNCASR	1	0	1	0.2
16	NAL	120	44	164	28.1
Total for all Organizations		295	288	583	
Percent for all Organizations		(50.6)	(49.4)	(100.0)	100.0
Chi-Square		278.811			
P Value		0.000			

(Numbers in brackets indicate percentages)

Key: ADA=Aeronautical Development Agency, AFTC=Air Force Technical College, ADE=Aeronautical Development Establishment, ASTE=Aircraft Systems Testing Establishment, CABS=Centre for Airborne Systems, CEMILAC=Centre for Military Airworthiness and Certification, C-MMACS=Centre for Mathematical Modelling and Computer Simulation, DARE=Defence Avionics Research Establishment, LRDE=Electronics and Radar Development Establishment, GTRE=Gas Turbine Research Establishment, HAL=Hindustan Aeronautics Limited, IAM=Institute of Aerospace Medicine, ISRO-ISTRAC=Indian Space Research Organization, IISc=Indian Institute of Science, JNCASR=Jawaharlal Nehru Centre for Advanced Scientific Research, NAL=National Aerospace Laboratories

XII HYPOTHESES EVALUATION

Keeping the Objectives of the study and the Hypotheses formed before the survey, the hypotheses were tested and evaluated. This section highlights testing of the Hypotheses.

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1. The Use of e-resources is more than the printed resources amongst the Aerospace Scientists

- Use of Conventional Sources of Information

Table-3: Use of Conventional Sources of Information

Sl No.	Organizations	Mean and CV	Types of Information Resources							
			Printed							
			Books	Journals	Databases	Technical Reports	Conference Proc.	Drawings	Specifications	Computer Programs
Mean Score on Conventional Resources	Mean		2.14	2.45	2.97	2.49	2.11	1.94	2.10	2.15
	CV		53.27	46.12	34.01	42.97	52.61	69.59	60.48	63.25
P Values			0.000	0.000	0.186	0.000	0.002	0.000	0.000	0.000

- Extent of Use of e-Resources

Table-4: Extent of Use of Electronic Information Resources

S.N	Organizations	Mean and CV	Use of e- Resources							
			e-resources							
			e-Books	e-Journals	e-Databases	e-Technical Reports	e-Conf. Proceedings	e-Drawings	e-Specifications	e-Computer Programs
Mean Score on Extent of Use of electronic Information Resources	Mean		2.35	2.45	2.02	2.13	1.82	1.55	1.75	1.83
	CV		55.32	55.51	62.87	61.50	70.88	85.81	77.14	75.40
P Values			0.001	0.000	0.116	0.000	0.000	0.039	0.022	0.099

It is seen from the above table that the total mean scores for both the convention sources of information(Print Journals) and the electronic sources of information (Electronic Journals) get the same priority of usage amongst the aerospace scientists and engineers. As far as usage of books are concerned, e-books gets a higher mean score(mean=2.35, CV=55.32) over printed books(mean=2.14, CV=53.27). For the rest of the sources of information, the conventional sources of information (printed material) projects a higher priority of usage amongst the aerospace scientists and engineers than the e-information resources.

- Forms of Journal Usage

Table-5: Various Forms of Journal Usage

SN	Organization s	Forms			
		Print	Electronic	Both Equally	Total
Total		122	96	365	583
Percent		(20.9)	(16.5)	(62.6)	(100.0)
Chi-Square		56.775			
P Value		0.002			

As far as the usage statistics of journal usage is concerned, a total number of 365 aerospace scientists and engineers representing 62.6% of the total sample size use both the Print and Electronic Journals equally. Hence both the forms of journals occupy the same priority.

- If Electronic? Form of e-Journal

Table-6: E-Journal Types

SN	Organizations	e-Journal Types			
		Offline (CD-ROM)	On-Line	Both Equally	Total
Total		52	327	204	583
Percent		(8.9)	(56.1)	(35.0)	(100.0)
Chi-Square		57.879			
P Value		0.002			

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If the only option is available as electronic medium, then the aerospace engineering community gives the highest priority to e-Journals amounting to 327 respondents and representing 56.1% of the total sample size.

❖ **Hypothesis Evaluation:** The use of e-resources and print resources are almost the same amongst the aerospace scientists and engineers. Hence the initially proposed hypothesis is not supported.

2. Instantly available e-resources heavily motivate the aerospace scientists and engineers.

● Feelings of Users towards e-Resources

Table-7: Feelings of Users towards E-Resources

S.N.	Organizations	Mean and CV	Feelings of Users			
			I can now do better research because of availability of electronic information resources	I need to rely on librarians more when searching for electronic information resources	It is much easier to find needed information online	I prefer access to electronic information resources than print resources
Mean Score on Feelings of users on e-Resources		Mean	3.24	1.69	3.30	2.83
		CV	30.25	68.05	26.67	40.63
P Values			0.002	0.200	0.011	0.445

It is seen from the above table that 'I can now do better research because of availability of electronic information resources(mean=3.24, CV=30.25)', 'It is much easier to find needed information online(mean=3.30, CV=26.67)' and 'I prefer access to electronic information resources than print resources get reasonably a good mean score. Hence, the factors mentioned above definitely motivate the aerospace scientists and engineers.

● Advantages of e-Journals

Table-8: Advantages of E-Journals

SN	Organizations	Mean and CV	Advantages											
			Current / up to date information	Ease of search	Ease of browsing	Multi-user access, fast access	Ability to download	24 hour access	Available before Print	Searchability of databases among Journals	e-back volumes are available	Non-availability of print volume	Easy backup availability	Multiple choice of formats (PDF, RTF, DOC and HTML etc.)
Mean Scores Obtained for Advantages of e-Journals Use		Mean	2.90	2.89	2.82	2.55	2.66	2.67	2.42	2.33	2.19	1.97	2.23	2.32
		CV	47.45	47.11	48.18	54.65	50.51	51.64	58.81	61.89	64.68	71.65	64.32	63.04
P Values			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000

This table once again shows that important factors like '24 Hour Access', 'Ease of Search', 'Multi-user access and fast access', 'Searchability', 'e-back Volumes availability', 'Multiple file download formats' definitely motivate the aerospace scientists and engineers to use more and more e-resources.

❖ **Hypothesis Evaluation:** 'Instantly available e-resources heavily motivate the aerospace scientists and engineers is proved'. Hence, the initially proposed Hypothesis is supported.

3. The electronic information resource needs of the scientists working in the aerospace organizations in Bangalore are homogeneous in nature.

● Extent of Use of e-Resources

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Table-9: Extent of Usage of E-Resources

S.N	Organizations	Mean and CV	Extent of Use of e- Resources							
			e-Books	e- Journals	e- Databases	e- Technical Reports	e-Conf. Proceedings	e- Drawings	e- Specifications	e- Comput er Programs
Mean Score on Extent of Use of electronic Information Resources		Mean	2.35	2.45	2.02	2.13	1.82	1.55	1.75	1.83
		CV	55.32	55.51	62.87	61.50	70.88	85.81	77.14	75.40
P Values			0.001	0.000	0.116	0.000	0.000	0.039	0.022	0.099

Analysis of Variance (ANOVA) was applied for testing the significant difference among the 16 mean scores attained from 16 aerospace organizations towards the extent of usage e-resources by the aerospace scientists and engineers. It is observed that all the 16 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., e-books, e-databases, e-technical reports, e-conference proceedings, e-drawings, e-specifications: *except for* e-Databases and e-computer programs ($P=0.099$).

● **Purposes of Use of e-Resources**

Table-10: Purpose of Usage of E-Resources

SN	Organizations	Mean and CV	Purposes										
			Basic scientific and technical information	Experimental techniques and methodology	Codes of standards and practices	Drawings and designs	Computer programs	In-house technical data	Product information	Technical specifications	Patents and inventions	Govt. rules and regulations	Economic information
Mean Scores on Purpose of use of e-Resources		Mean	3.23	2.47	2.19	1.72	1.83	2.01	2.50	2.48	1.72	1.73	1.70
		CV	28.79	48.99	58.45	73.26	69.40	59.70	48.00	48.79	73.26	71.68	72.94
P Values			0.00	0.137	0.019	0.000	0.005	0.000	0.000	0.005	0.327	0.000	0.005

Analysis of Variance (ANOVA) was applied for testing the significant difference among the 16 mean scores attained from 16 aerospace organizations towards the 'Purpose of using e-Resources'. It is observed that all the 16 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., 'Basic scientific and technical information', 'Codes of standards and practices', 'Drawings and designs', 'Computer programs', 'In-house technical data', 'Product information', 'Technical specifications', 'Govt. rules and regulations', 'Economic information' *except for*: 'Experimental techniques and Methodology' and 'Patents and Inventions'.

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● **Purpose of Visiting e-Journal Sites**

Table-11: Purpose of Visiting E-Journal Scientists by the Aerospace Scientists and Engineers

SN	Organizations	Mean and CV	Purpose								
			Search bibliographic information	Browse the Table of Contents (TOC)	Browse any Abstracts	Access the full text of articles	For gathering information	Facilitate teaching	Keep updated in your subject	Writing proposals, reports, thesis etc.,	Prepare for technical presentations
Mean Scores Obtained for Purpose of Visit to e-Journal Sites	Mean		1.99	1.92	2.15	2.46	2.31	1.67	2.47	1.88	2.08
	CV		64.95	64.18	57.04	52.94	57.53	75.87	52.75	66.03	61.29
	P Values		0.000	0.002	0.000	0.000	0.000	0.002	0.000	0.000	0.017

Analysis of Variance (ANOVA) was applied for testing the significant difference among the 16 mean scores attained from the scientists and engineers of the aerospace organizations for ‘Purpose of visit to e-journal sites’. It is observed that all the 16 aerospace organizations show a significant difference ($P < 0.05$) in their mean scores viz., ‘Search bibliographic information’, ‘Browse the table of contents (TOC)’, ‘Browse only Abstracts’, ‘Access the full text of articles’, ‘For gathering research information’, ‘Facilitate teaching’, ‘Keep updated in your subject’, ‘Writing proposals, reports, thesis etc.’, ‘Prepare for technical presentations’.

❖ **Hypothesis Evaluation:** ‘The electronic information resource needs of the scientists in the aerospace organizations in Bangalore are Heterogeneous in Nature’. Hence the initially proposed Hypothesis is not supported.

4. **Lack of adequate training to the scientists for access and use of electronic information resources for scientific research is one of the inevitable barriers and difficulties faced while seeking information**

● **Skills acquired to Use e-Resources**

Table-12: Skills Acquired to Use E-Resources

Sl. No.	Organizations	By Trial and Error	Help from the Library Staff	Through Friends / Colleagues	Through Publisher’s Presentations	Total
	Total	388	107	368	138	1001
	Percent	(38.76)	(10.69)	(36.76)	(13.79)	(100.00)
	Chi-Square	27.768				
	P Value	0.023				

From the above example, it is seen that only 107 respondents representing 10.69% of the total sample size have opted for ‘Help from the Library Staff’ towards skills required to use e-Resources. Hence, lack of adequate training does not necessarily happen to be the inevitable barrier while seeking or using e-resources. The aerospace scientists and engineers as it is seen from the above table generally learn to seek information either through ‘Trial and Error’, or ‘Through Friends / Colleagues’ and finally through the ‘Publisher’s Presentations’.

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● **Reasons for Not Using e-Journals**

Table-13: Reasons for Not Using E-Journals

SN	Organizations	Reasons for Not Using e-Journals											
		Not Familiar with e-Journals			Need Training			Our Library does not have access to e-Journals			Not many Journal titles are available relating to my topic in Electronic Form?		
		No	Yes	Total	No	Yes	Total	No	Yes	Total	No	Yes	Total
Total [583]	450	133	583	467	116	583	446	137	583	455	128	583	
Percent	(77.2)	(22.8)	(100.0)	(80.1)	(19.9)	(100.0)	(76.5)	(23.5)	(100.0)	(78.0)	(22.2)	(100.0)	
Chi-Square	-	43.59	-	-	54.30	-	-	71.81	-	-	21.61	-	
P Values	-	0.000	-	-	0.000	-	-	0.000	-	-	0.118	-	

From the above table it is seen that only 116 representing 19.9% respondents amounting out of the total sample size of 583 aerospace scientists and engineers have mentioned that they need training. The remaining 467 respondents amounting to 80.1% feel that it is not the main issue. Other barriers like ‘Our Library does not have access to e-Journals’, ‘Not familiar with e-Journals’ and ‘Not many journal titles are available relating to their research topic in electronic form’ seem to be the real bottlenecks as far as access and use of e-resources are concerned.

● **Role of the Library in Promoting e-Resources Usage**

Table-14: Role of the Library in Promoting E-Resources Usage

S. N.	Organizations	Mean and CV	Importance of Following Inputs Towards Usage of e-Resources				
			Well organized home page of library with link to e-journals	Assistance from Library Staff in handling e-Journals	Library Printed/Online Guide to e-Journals	Library Training/Orientation	Alert Service relating to addition of New Journals
Total mean scores of importance of vital inputs towards usage of e-Resources	Mean	2.71	2.10	2.17	1.83	2.11	
	CV	54.93	65.04	62.75	73.77	69.16	
P Values		0.000	0.002	0.002	0.000	0.000	

Again from the extract from the main table it is seen that ‘Library Training / Orientation’ gets the least total mean score of 1.83(CV=73.33). The aerospace scientists and engineers have indicated that ‘Well organized home page of the library with link to e-journals’, ‘Library Printed/Online Guide to e-Journals’, ‘Alert Services Relating to Addition of New Journals’ and finally ‘Assistance from Library Staff in handling e-journals’ are the more significant issues or inevitable barriers towards access and use of e-resources.

Hypothesis Evaluation: ‘Lack of adequate training by the library staff to the aerospace scientists and engineers is not the most significant inevitable barrier or difficulty faced while seeking information’. Hence, the initially proposed is not supported.

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XIII. CONCLUSION

Some of the interesting conclusions that could be drawn from this study are elaborated below:

● Use of Electronic Information Resources

- ❖ The most preferred 'conventional sources of information' (in the order of priority) by the aerospace scientists and engineers happen to be (a) 'Databases', followed by (b) 'Technical Reports', (c) 'Journals', (d) 'Computer Programs', (e) 'Books', (f) 'Conference Proceedings' and finally (g) 'Drawings'
- ❖ The main source of awareness about 'e-Resources' amongst the aerospace scientists and engineers in the order of priority are primarily through (a) 'Serendipity and by browsing or looking for e-materials', (b) 'Citations in a report / journal / conference proceedings', (c) through 'Bibliographic databases search (indexing and abstracting databases)', (d) 'International search of library resources', (e) 'Announcements in journals like STAR', (f) 'Current awareness publications like SCAN, (g) 'Reference to the author by the librarian / technical information specialist, (h) Organizations like NASA send them to the Author', (i) 'The author sends directly to another author' and finally, (j) and through other e-resources.
- ❖ Regarding the extent of use of e-resources and its usefulness in research work, the aerospace scientists most preferred e-resources in the order of priority are: (a) 'e-Journals, (b) 'e-Books, (c) 'e-Technical Reports', (d) 'e-Databases, (e) 'e-Computer Programs', (f) 'e-Conference Proceedings', (g) 'e-Specifications', and finally, followed by (h) 'e-Drawings'
- ❖ Regarding the feelings of the aerospace scientists and engineers towards e-resources, the findings show that, (a) 'It is much easier to find information Online' as one of the most preferred option, this is followed by (b) 'I can now do better research because of availability of electronic information resources', this is followed by (d) 'I prefer access to electronic information resources than print resources', (e) Finally, 'I need to rely on the librarians more when searching for electronic information resources' gets the lowest mean score.
- ❖ With specific reference to various skills required to make use of the various e-resources effectively (information literacy) by the aerospace scientists and engineers, the responses indicate that a large number of these scientists and engineers acquire these skills by (a) 'Trial and Error', then by (b) 'Through their Friends and Colleagues', (c) 'Through Publisher's Presentations, and finally through (d) 'Taking Help from their Own Library Staff'.
- ❖ The main purpose of usage of e-Resources by these aerospace scientists and engineers are for obtaining (a) 'Basic scientific and technical information', followed by (b) For 'Product Information', (c) For knowing about 'Technical specifications', (d) 'Experimental techniques and methodology', (e) 'Codes of standards and practices', (f) 'In-house technical data', (g) 'Computer Programs', (h) 'Govt. rules and regulations, (i) 'Patents and inventions, (j) 'Drawings and design' and 'Economic information' get the least priority.
- ❖ A technical reports (also called as a scientific report) is a document that describes the process, progress, or results of technical or scientific research or the state of a research problem. Today, they are a major source of scientific and technical information. The most preferred e-Technical Reports by the aerospace scientists are: (a) 'USA, NASA', followed by (b) 'USA, AIAA', (c) 'Indian NAL', (d) 'AGARD', (e) 'British ARC and RAE', (f) 'ESA', (g) 'French ONERA', (h) 'German DFVLR, DLR and MBB', (h) 'Dutch NLR', (k) 'Russian TaAGI', and finally, (l) 'Japanese NAL' in the order of priority.

● Internet Search Engines and Scientific Web Sites.

Aerospace Scientists frequently depend upon various Internet Search Engines and also regularly visit specific scientific web sites to keep in touch with global R&D happenings. Some of the most frequently used Internet search engines and scientific web sites referred by this aerospace engineering community are presented in this section.

- ❖ The most frequently used Internet search engines are: (a) 'Google', followed by (b) 'Yahoo', (c) 'Alta Vista', (d) 'Lycos', (e) 'Galaxy', (f) 'Magellan' and 'Infoseek' almost get the same priority of usage, followed by (g) 'Web Crawler', (h) closely followed by 'Inktomi' and 'Open Text' and the least priority is represented by (i) 'Northern Light'.

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- ❖ Several scientific web sites frequently get referred by the aerospace scientists and engineers. They are listed in the order of priority and usefulness. (a) 'Google Scholar', (b) 'Google Book', (c) 'SCIRUS', (d) 'Search engine for aerospace and defense debuts', (e) 'OJOSE', (f) 'Directory of Open Access Journals – DOAJ', (g) 'JSTOR', (h) 'Biolink', (i) 'Athenus', (j) 'Scientific Commons', (k) 'SciCentral Gateway', (l) 'SciSeek', (m) 'CiteSeer', (n) 'The Virtual Technical Reports Center' and ISI get the same priority and usage, (o) 'MetaCrawler', (p) 'News Trawler' and 'WebData.com' get equal usage, (q) 'Alphasearch' and 'BiHub' have a similar usage.
- **Use of Electronic Journals**
- ❖ Regarding the most preferred form of electronic journals and its usage is concerned, a large number of aerospace scientists have opted for both 'Print and Electronic' versions equally. This is followed by 'Print' alone and 'Electronic' alone.
- ❖ Amongst the electronic versions, (a) 'On-Line e-Journals' get the highest priority, followed by, (b) 'Both Equally' and (c) CD-Rom (Off-Line) the least.
- ❖ The aerospace scientists and engineers visit various e-journals for various purposes. However, the most important purpose in the order of priority are: (a) 'Keeping updated in their subject', followed by (b) 'Access for full-text of articles', (c) 'For gathering information', (d) 'Browse for any Abstracts', (e) 'Prepare for technical presentations', (f) 'Search for Bibliographic Information', (g) 'Browse the Table of Contents', (h) 'Writing proposals, reports, thesis etc.', and finally, the least priority goes to (i) 'Facilitate Teaching'.
- ❖ It is observed that the aerospace scientists and engineers are very comfortable in accessing e-Journals mainly through, (a) 'Through their Library Consortia', followed by, (b) 'Professional Memberships', and finally through, (c) 'On-Line Payments'.
- ❖ With regard to the aerospace scientists and engineers strong perceptions about e-journals, it is observed that, (a) 'Keeps Current about Global R&D' happens to be the most important priority, this is followed by, (b) 'Distribution of Articles Easier and Less Costly', (c) 'More Frequently Used than Printed Journals', (d) 'Enhances Access / Visibility to Scientific Papers', (e) 'Features like Editorial News, Links to Other Papers, Peer Reviews, Alerts are Useful', (f) 'Greatly Decreases Time Spent on Articles Search or Visiting the Library', (g) 'More User Friendly than Printed Journals', (h) 'Listing Articles under Hot Articles / Most-Viewed Articles, etc. are Useful', (i) 'Increases the Number of Papers read which are outside the Primary Discipline', (j) 'Increases Scholarly Productivity in terms of Publishing Papers', (k) 'Increases Over-Exposure to Non-Peer Reviewed Papers', and finally, the least priority is (l) 'Decreases the Quality of Research Literature'.
- ❖ As far as the most important factors that decide the scientists' choice for publishing papers in e-journals are concerned, all the scientists and engineers representing the 16 aerospace organizations have responded in the following manner. It is observed that All the key elements of the factors like: (a) Impact Factor, (b) Acceptance Criteria, (c) Speed of Peer Review and finally, (d) Online Submission Facility show a significant association amongst the 16 aerospace organizations. This means that the percentage of preference for the above mentioned variables is not approximately the same [Not Uniformly distributed] amongst the 16 Aerospace Organizations.
- ❖ The aerospace scientists and engineers frequently refer to some core aerospace engineering e-Journals for their day to day and research work. From the responses received from about 583 aerospace scientists and engineers, it is observed that, the most frequently referred core aerospace engineering e-journals in the order of preference and priority are: (a) 'Aerospace Science and Technology', (b) 'Progress in Aerospace Sciences', (c) 'Journal of Aerospace Engineering', (d) 'IEEE', (e) 'IEEE Transactions Electronic and Aerospace Systems', (f) 'Web of Science'. These are then followed by (g) 'Online Journals: Aerospace', (h) 'Journal of Turbo and Jet Engines', (i) 'The Journal of Failure Analysis and Prevention (ASM International)', (j) 'European Space Bulletin – ESA', (k) 'Informatics –Gate' and finally followed by 'International Journal of Satellite Communications and Networking'.
- ❖ There are various means and ways in which the aerospace scientists and engineers locate their required articles from the e-Journals. The most preferred ways are: (a) 'e-Journal On-Line List', (b) 'Directly

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from the Publisher's Web site', (c) 'Subject list located on the Publisher's Website', (d) 'Access/Link provided at your desktop through the Organization's Intranet', (e) 'Alphabetical list located on the Publisher's Website', (f) 'From a Database', and finally from (g) 'Personal

● Use of e-Databases and On-Line Databases

❖ Aerospace scientists and engineers frequently use certain very important core aerospace engineering e-Databases. Some of the most frequently used ones in the order of importance and priority are: (a) 'Aerospace Databases', (b) 'AIAA Meeting Papers', (c) 'American Institute of Aeronautics and Astronautics', (d) 'NASA Technical Reports Server (NTRS)', (e) 'IEEE Explore', (f) 'Aerospace Industries Association', (g) 'NTIS (CSA)', (h) 'Aerospace and High Technology Database through (CSA)', (i) 'SAE International', (j) 'Thomas Register and 'Aerospace and Defense Industry Data Finder' get the same weightage, this is followed by: (k) 'Inside Science', (l) The lowest priority goes to 'Compendex' and 'INSPEC'.

❖ A large number of aerospace engineering related encyclopedias, handbooks and dictionaries are frequently referred by the aerospace engineers and scientists. Some of the most popular ones are: (a) 'Aeronautical Engineer's Data Book', (b) 'AIAA Aerospace Design Engineer's Guide', (c) 'The Standard Handbook for Aeronautical and Astronautical Engineers', (d) 'Aerospace Facts and Figures', (e) 'Jane's All the World's Aircraft', (f) 'Jane's Space Directory', (g) the least referred are 'The Complete Book of Space Flight' and 'International Reference Guide to Space Launch Vehicles'.

❖ A large number of aerospace indexing, abstracting and citation services are frequently referred by the aerospace engineers, some of the most important ones are: (a) 'NASA – Technical Reports Server (NTRS)', (b) 'ISI Web of Science', ISI Citation Indexes and ISI Web of Knowledge' almost get the same usage priority, this is followed by, (c) 'NASA Technical Information Services Indexes (NTIS)', (d) 'Aerospace and High Technology Database (CSA Abstracts), (e) 'SCOPUS' and 'Search Tools' get the same priority, this is followed by, (f) 'Engineering Index (Compendex Plus)' and 'INSPEC' respectively.

❖ After the pioneering initiative by the Cranfield University in setting up AERADE (Aerospace and Defense Resources), a Gateway and Portal dedicated to aerospace and defense resources on the Internet, several other Gateways have mushroomed to serve the scientific cause and needs of the aerospace engineering community. Some of the most important Gateways referred by these aerospace scientists and engineers in the order of usage importance are: (a) 'NASA', (b) 'FAA', (c) 'Space Today Online', (d) 'Yahoo Index for Aeronautics and Aerospace', (e) 'AERADE', (f) 'IAIN', (g) 'GALCIT', and finally, (h) 'ERAU'.

❖ Aerospace scientists and engineers mostly attached to production oriented aerospace organizations, refer to a large number of Aerospace Standards. There are several aerospace standards available. Some of the most frequently referred are: (a) 'ARINC 429 P1', (b) 'MIL-STD-704', (c) 'AIA NAS SET', (d) 'DO178-B', (e) 'ARINC 600', (f) 'CFR 1-59', (g) 'NAS 1352'.

● Role of the Library in Promoting e-Resources Usage and the Importance of Aerospace Digital Libraries.

❖ All scientific R&D libraries play a great role in promoting the usage e-resources amongst its engineering community. Certain specific questions were asked in the questionnaire with regard to the important role played by libraries in promoting e-resources usage. The responses received from the aerospace scientists and engineers as vital inputs in promoting e-resources usage are presented in detail here: The aerospace engineering community give topmost importance to (a) 'Well Organized Home Page of Library with link to e-Journals', this is followed by, (b) 'Library Printed / Online Guide to e-Journals', (c) Alert Service Relating to Addition of New Journals', and finally, (d) 'Assistance from the Library Staff in Handling e-Journals'.

❖ The aerospace engineering community also frequently makes use of aerospace related 'Digital Libraries'. Some of the most important ones regularly used/referred by these scientists are: (a) 'NACA Digital Library', (b) 'Scientific and Technical Information Network (STINET)', (c) 'The Wright Air Development Center / Digital Collection', and finally, (d) the 'DOE Information Bridge'.

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● Web Log or Transaction Log Analysis for On-Line e-Journal Usage Studies:

Web Log Analysis has immense potential for studying online journals use and their user's information seeking behavior. With the widespread use of computer and network technologies for facilitating access to scholarly journals, this new technology has emerged for studying journal usage and scholarly information-seeking behavior. Log files contain data about many of the details of the users' interaction with the system. Hence, some researchers have adopted log analysis to find out about the use of electronic journals in terms of both the volume and patterns of use, Guruprasad et al., [16, 17, 18].

A different type of questionnaire was distributed to ascertain the full-text e-journal downloads to the Network Administrators / Web Administrators / Chief Librarians amongst the aerospace organizations. From the responses received and analyzed it was found that:

- ❖ All the responding aerospace organizations, heavily make use of aerospace related electronic journals from the various publishers. Cumulative e-journal downloads for the 4 years, namely, 2005 – 2008 were calculated and they reflect the following trend: (a) 'Elsevier – Science Direct' seems to be the most popular e-journal publisher, followed by (b) 'Web of Science' (c) 'Elsevier', (d) 'Springer Link', (e) 'ASME', (f) 'Emerald', (g) 'John Wiley (Inter-Science)', (h) 'AIP', (i) 'ASCE', (j) 'CUP', (k) 'Taylor and Francis', (l) 'OUP', (m) 'RSC', (n) 'IEEE', (o) 'Blackwell', (p) 'AIAA', (q) 'AEAT', (r) 'American Mathematical Society', (s) 'INSA', (t) 'IAS', (u) 'Air Force – Airman', and finally, (v) 'Journal of Atmospheric Sciences (JAS)' in that order.

The most significant conclusion that could be drawn from this research survey is that 'The Use of Electronic Information Resources' is the same for all scientists and engineers irrespective of whichever discipline they belong to, however, the biggest advantage that the scientists and engineers in the field of Aerospace have is that – the majority of them are very well exposed to the 'Electronic Environment' and 'Information Technology' by the nature of their work itself. Hence the 'Use of Electronic Information Resources' are highly expected from them particularly as an 'Integrated Information System to their Learning and Working Environment'.

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BIOGRAPHY



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