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Information needs of scientists and engineers in electronic environment: A case study of Indian exploration and production industry

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Information is the key element for any kind of research and development. With the introduction of computers and other telecommunication facilities, information is now available to the scientists in a variety of formats. The study explores the habit of use of documents and the library by the scientists, engineers and technologists of Indian petroleum industry in the electronic era. It attempts to correlate the need of information with the habits of using of library. Concludes that information needs and habit of library use of scientists and technologists are related to their rank in the organization. The online access services, offline digital sources and Internet services are the most popular library services in upcoming electronic culture. With the emerging needs and increased fascination of scientific and engineering work groups for handling and use of electronic information resources, the information centres and libraries are expected to acclimatize with the inherent pressing needs of changed mindset of users.

Introduction

Information is a key element for any research and development work. Presently scientists, engineers and technologists are getting their desired information easily and in a short time with the help of computer and telecommunication facilities. The scientists and technologists working in oil exploration and production are also producers and users of information as in other areas of science and technology. The present study focuses on the information needs of the scientists and technologists of the Oil and Natural Gas Corporation Limited (ONGC), a leading oil exploration and production company in India.

ONGC is evolving as a fully integrated, upstream petroleum company, exploring and producing oil and natural gas from acreages both on land and offshore in diverse logistic conditions, from rugged mountains to deserts and deep oceans. ONGC has emerged to be a world-class oil and gas company integrated in energy business, with dominant Indian leadership and global presence. At ONGC, there is a constant demand of the strategic resource like "information" by the scientists and technologists to conduct research by utilizing information resources of its own and others.

With the advent of the new millennium, major trends visualized are the expansion of bibliographic services of knowledge updates, licensing policies and consortia, information delivery to scientists' desktop, full text electronic publishing, linking of databases and library holdings, etc. So it is expected that there might have been some changes that have taken place with respect to information needs of scientists and technologists particularly with the introduction of ICT. Therefore, an attempt has been made to find out the information needs of the scientists and technologists engaged in the core exploration and production business and also evaluate the library and information services available to them by the organization.

Objectives of the study

1. To find out the extent of current information needs and their uses;
2. To study the need of electronic information for exploration and production research work;
3. To determine the variety and extent of use of electronic sources; and
4. To correlate the frequency of information needs and habits of library use by the scientists and technologists.

Review of literature

A review of the literature reveals that a number of studies exist on information needs study of scientists. Palmer stated that the scientists are not "empty buckets"; they are individuals who not only collect, store, retrieve and use information, but also create it[1]. The information produced by them is published in the form of conference papers, print papers and as reports. The scientists and technologists mostly use the information systems at their disposal to carry out their investigations. Visvesvaraya studied the engineering information needs and services in Indian context and proposed for development of an information system for national development[2]. The study also indicated the need for engineering information under the framework of NISSAT. Bernard et al found that the need and demand of geoscientists and engineers for and use of information is greatest in the initial period of each project[3].

Raina derived that scientists prefer to do most of their readings in their workrooms or laboratories[4]. Only for occasional reference purpose, they would feel like going to the library and 75 percent of them get their literature from outside the library that is by asking the authors for reprints. Holland and Powell undertook a survey of information seeking and use habits of engineers and their communication in technical aspects[5]. They estimated that among engineers, the searching and reading habits of information seeking would have been at the average of ten hours and more per month rather than searching the formal sources of libraries.

Jandt and Nemnich studied the use of Internet and the World Wide Web in job search and career information[6]. Llull contributed on the issue on information seeking and communicating behaviour of scientists and engineers[7]. Herman examined the transition to electronic information era from the published literature in the wider context of the impact of changing information environment in three major aspects: creation of knowledge, preservation of information and communication of knowledge and information in the conduct of research, and identified its influence on information needs[8]. Herman also attempted to portray as to how users would start harnessing the new technologies for scholarly information gathering endeavors. Bishop and Peterson discussed the role of information in technology transfer and presented key findings on the information needs and communication patterns of scientists and engineers[9].

Missingham stated that the changing research environment due to the introduction of Internet has brought several issues related to the scientists that is adapting information pattern to the new media, ongoing browsing as opposed to new project searching, and the ability to find quality information[10]. It is also described that in this new world of bits and bytes, radical changes continue to occur in communication of information, the behaviour required to discover information and also the value of services of information centres and libraries.

Information resource use potential of ONGC

Information is the key input to the modern exploration and production business in the present era of competitive open market economy. Appreciating this, ONGC has taken several initiatives to spread IT culture. The libraries attached to the various centres of the organization also play an important role in knowledge transfer on the latest know-hows, technological advancement and global oil scenarios, and other upcoming challenges of E&P business and the libraries of ONGC act as an information pool for effective decision-making processes and knowledge enrichment of entire organization.

ONGC till now has established twenty libraries that function under the control of Assets/ Work centres/ Plants/ Projects and Institutes. Among them, the central library is established at Headquarters in Dehradun and huge collection of books and journals and number of databases which are available both on-line and offline. Some of the core databases available in the libraries on CD-ROM are: Petroleum Abstracts, Georef Index, ONGC Bulletin Image Library, API Standards, BIS Standards, ASTM Standards, etc. Apart from these, the libraries are having the facilities of Internet browsing and connectivity with IMMS, ICNET and SHRAMIK systems of ONGC.

Nature of ONGC library users

Fifty one percent of the ONGC work force includes scientists and technologists who specialize in various fields such as geology, geophysics, geochemistry, production engineering, drilling engineering, reservoir engineering, petroleum engineering, finance, human resources and information technology. These technical persons also work at all levels of executive hierarchy spanning E-0 to E-9. The top-level management who takes final decision and policy making fall within the group of E-6 to E-9.

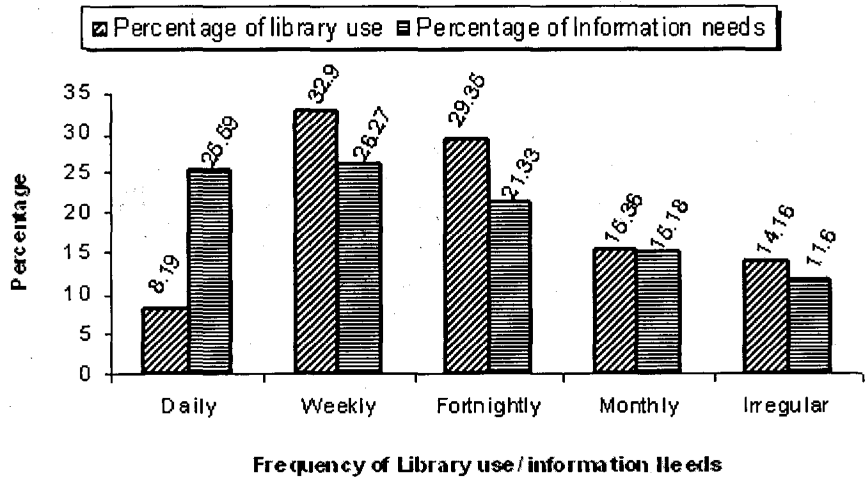

Fig. 1 - Correlation between the frequency of information needs and library use

Methodology

The present analysis is based on the information needs of scientists and technologists of ONGC[11]. The duties and responsibilities of these groups of personnel in the organization vary in accordance with the organizational needs across the entire gamut. The specialization of individual scientists and technologists are prone to deviate according to the demand of assignments of regional work centres. A survey method was applied to collect the data from the scientists, engineers and technologists working at different work centres and institutes of ONGC. As it was a heterogeneous group no specific sampling technique was applied. However, the sample contains a population of 54.99 percent of the total scientists and technologists. The results of this study are thus derived from the data collected through observations and questionnaire method.

Results and discussion

Information use vs information needs of ONGC scientists

There is a close relationship between the information needs of scientists and their library use. Out of the 586 respondents nearly 26.27 per cent need information on weekly basis and about 25.59 per cent need information daily. The scientists and technologists using information every fortnight form the third highest majority with 21.33 percent, whereas those who need information once a month is 15.18 percent. About 11.60 percent constitute irregular users of information requiring information, occasionally.

The data about the correlation between the information use vs information needs of ONGC scientists is shown in figure 1. It can be seen from the figure that minimum number (8.19%) of scientists and technologists use their library daily, whereas maximum number (32.9 %) of the scientists and technologists visit library at least once a week. Similarly 29.35 % of the personnel visit the library once a fortnight, 15.36% use their libraries once a month and 14.16% are occasional users of their libraries.

Scientists and technologists working at initial level (E-0) and at top level (E-6) do not visit the library every day (Table 1), which is correlated to the fact that they also do not need information daily (Fig: 2). Among the scientists and technologists, maximum number (54.55%) of the top-level executives (E-6) visit library once in a month (Table 1) but maximum of them have expressed their needs for information every fortnight. It is observed that majority of scientists and technologists at lower level (E-0 to E-2) are occasional users of the library and also maximum of E-0 and E-6 level are occasionally in need of information.

Maximum number of E-3 scientists and technologists (19.64%) visit library daily. Similar situation is seen

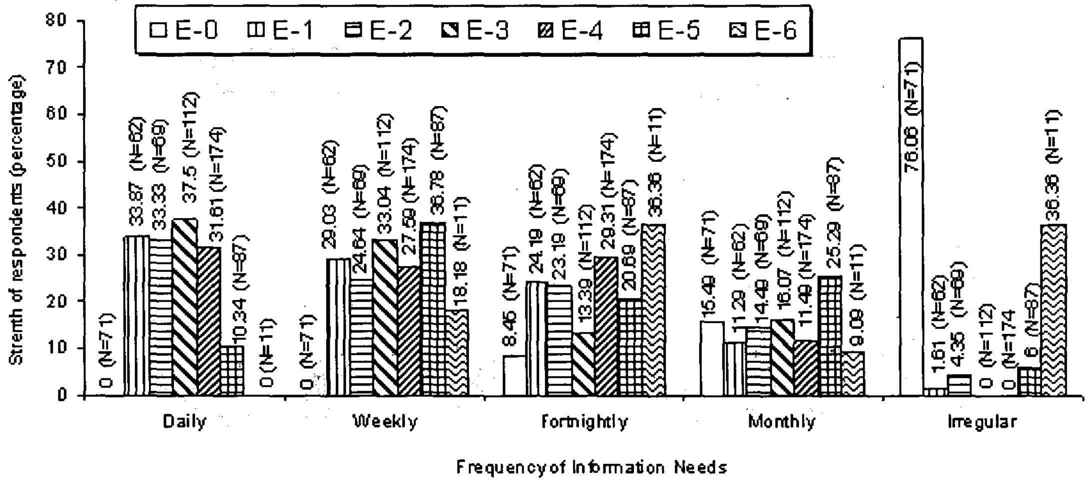

Fig. 2 - Comparison of frequency of information needs of scientists and technologists in different Levels (N=total respondents in respective levels)

Table 1 - Frequency of library visit among different levels of scientists & technologists

S.No	Frequency of visit	Levels of Scientists & technologists						
		E-0(N=71)	E-1(N=62)	E-2(N=69)	E-3(N=112)	E-4(N=174)	E-5(N=87)	E-6(N=11)
1.	Daily	0	03(4.84)	02(2.9)	22(19.64)	18(10.34)	03(3.45)	0
2.	2-4 times a week	0	06(9.68)	08(11.59)	17(15.18)	18(10.34)	15(17.24)	0
3.	Once a week	15(21.13)	09(14.52)	12(17.39)	29(25.89)	41(23.56)	22(25.29)	01(9.09)
4.	Once in a fortnight	17(23.94)	11(17.74)	20(28.99)	31(27.68)	67(38.51)	23(26.44)	03(27.27)
5.	Once in a month	18(25.35)	13(20.97)	11(15.94)	02(1.79)	26(14.94)	14(16.09)	06(54.55)
6.	Occasional	21(29.58)	20(32.26)	16(23.19)	11(9.82)	04(2.3)	10(11.49)	01(9.09)

regarding information needs of the respondents at E-3 level (37.5%) who are in need of information (Fig. 2).

However, 31.61% of E-4 level scientists and technologists require information daily. Of all, most (42.53%) of the scientists and technologists of E-5 level need information 'weekly'. On the contrary, scientists and technologists of E-6 level have expressed their information needs and views in favour of monthly requirements of their subject fields. However, majority of the scientists and technologists of E-0 level are quite irregular (76.06%) in their information requirement. The executives working at this level are perhaps not in need of information either 'daily/ or weekly'. But the scientists and technologists at E-1 to E-6 cadre need information almost in all frequency of intervals i.e., daily, weekly, fortnightly, and monthly.

Need for information sources

Information needs of scientists, engineers and technologists are equally based on the knowledge about those sources of information and accessibility of these information sources. The scientists, engineers and technologists in general use encyclopedias, handbooks, textbooks, periodicals, abstracts, indexes, standards, patents, etc., for their research and development work. Regarding the need for sources of information, it is observed that the scientists and technologists working in E-0 level only need encyclopedias and E-1 level needs encyclopedias, bibliographies and grey literature (Table 2). The top-level scientists and technologists are in need of newspapers' clippings and annual reports. Whereas the scientists and technologists at E-2 and E-5 level needs almost all the 17 categories of sources of information. When the sources of information are ranked (Table 2)

Table 2 - Need of information sources

S.No Rank	Information sources	Responses of scientists and engineers E-0	E-1	E-2	E-3	E-4	E-5	E-6	Total scores
1	In-house Reports	0	0	0	101	162	38	0	301
2	Periodicals / Journals (current)	0	0	40	58	100	43	0	241
3	Annual Reports	0	0	0	0	150	68	4	222
4	Standards & Specifications	0	0	28	33	72	40	0	173
5	Published Reports	0	0	0	30	92	39	0	161
6	Conference Proceedings	0	0	20	66	52	0	0	138
7	News Paper Clippings	0	0	0	17	51	42	6	116
8	Handbook / Data Book	0	0	0	0	72	41	0	113
9	Technical Maps / Drawings	0	0	24	27	38	0	0	89
10	Text Books	0	0	32	29	19	0	0	80
11	Periodicals / Journals (back vol.)	0	0	31	21	20	0	0	72
12	Encyclopedias	10	18	9	15	0	0	0	52
13	Bibliographies	0	22	21	0	0	0	0	43
14	Abstracts	0	0	0	20	12	0	0	32
15	Grey Literature	0	18	12	0	0	0	0	30
16	Indexes	0	0	0	10	8	0	0	18
17	Digest	0	0	0	0	1	0	0	1

on the basis of their needs among the scientists and technologists , it is seen that the in-house reports got the top rank (301), followed by current periodicals (241), annual reports (222), standards and specifications (173) and published reports (161), and so on. The abstracts and indexes although considered as a very important secondary source of information ranked lower in the needs among the executives.

Need of electronic sources of information

To derive extent of need of information sources in electronic formats, these are categorised into: bibliographic database, full text database, factual database, directories, patents and preprints, technical standards, etc. 'Bibliographic databases' in electronic form are required only by E-1, E-2, and E-3 scientists and engineers (Table 3). The 'full text databases' are needed by the E-1 to E-4 scientists and technologists. The 'factual databases' in electronic format are required by E-3 to E-6 and above scientists and technologists. 'Directories in electronic formats' are frequently needed only by E-3 to E-6 and above the junior executives of E-0 to E-2 of engineering and scientific groups. 'Patents information in electronic format' is required by few groups of scientists and technologists serving at the level of E-3 and E-4. The ranks of the important information sources in electronic form are also derived on the basis of their needs. Here, the scientists and technologists have shown their options in more than one information source. So, the total scores obtained are more than the number of respondents (Table 3).

The full text databases in electronic format, recorded the highest (47.61%) percentage of demand.

The factual databases (31.05%) and directories in electronic format (30.88%) were also reasonably needed by the scientist and technologists. Bibliographic databases (22.18%), and patents information (1.87%) were needed by fewer scientists/technologist.

The demand of electronic sources of information among the scientists and technologists at different levels of their

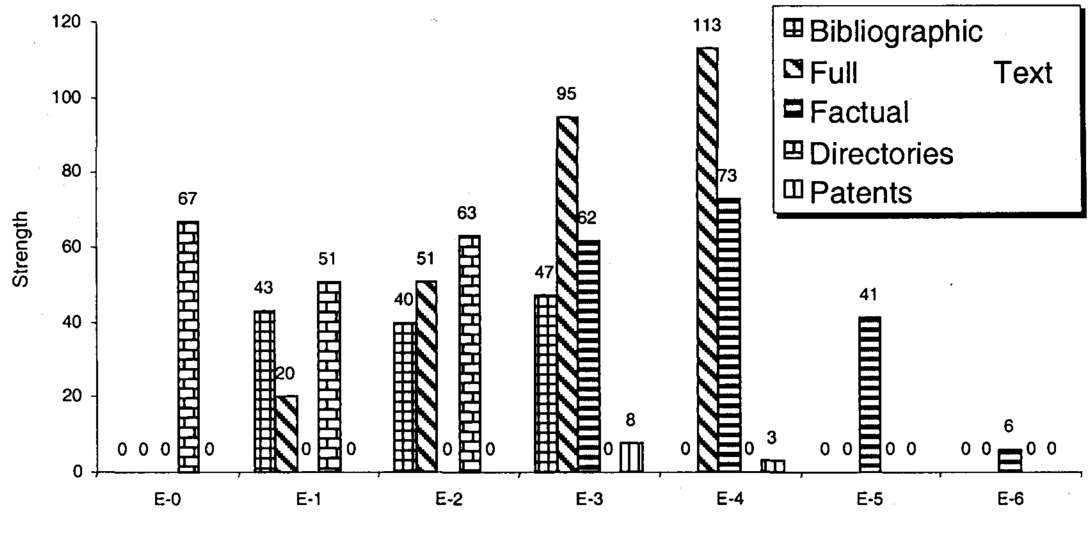

Fig. 3 - Comparison of use of electronic sources of information among scientists & technologists (E-0 to E-6)

Table 3 - Rank of the electronic sources of information

S. No	Electronic sources of Information	Rank	Scores by levels of scientists and engineers							Total Scores
			E-0	E-1	E-2	E-3	E-4	E-5	E-6	
1.	Full Text Databases	1	0	20	51	95	113	0	0	279
2.	Factual Databases	2	0	0	0	62	73	41	6	182
3.	Directories in Electronic Formats	3	67	51	63	0	0	0	0	181
4.	Bibliographic Databases	4	0	43	40	47	0	0	0	130
5.	Patents Information in Electronic Formats	5	0	0	0	8	3	0	0	11
Increased responses showing multiple choices opted			67	114	154	212	189	'41	6	783
Total Respondents			71	62	69	112	174	87	11	586

positions are compared. In accessing 'bibliographic databases in electronic format, scientists and engineers in the levels of E-1, E-2 and E-3, have got nearly almost the same scores, i.e. 47(36.15%), 43(33.07%), and 40(30.76%) respectively (Fig. 3).

The need of 'full text databases' is much more among scientists and technologists, which received highest scores at E-4 level (40.50%), and then those of E-3 (34.05%). Whereas the scientists and technologists of level E-2, (18.27%) and E-1 (7.16%) are at low profile demand. The need of factual databases is much more in E-4 (40.10%); E-3 (34.06%) and E-5, (22.52%). The need of directories in electronic formats is maximum with E-0 (37.01%) scientists and technologists, and the status at the levels of E-2, (34.80%), and E-1 (28.17%) is worth mentioning. The patent information is observed very bleak in its needs, however, E-3 and E-4 scientists

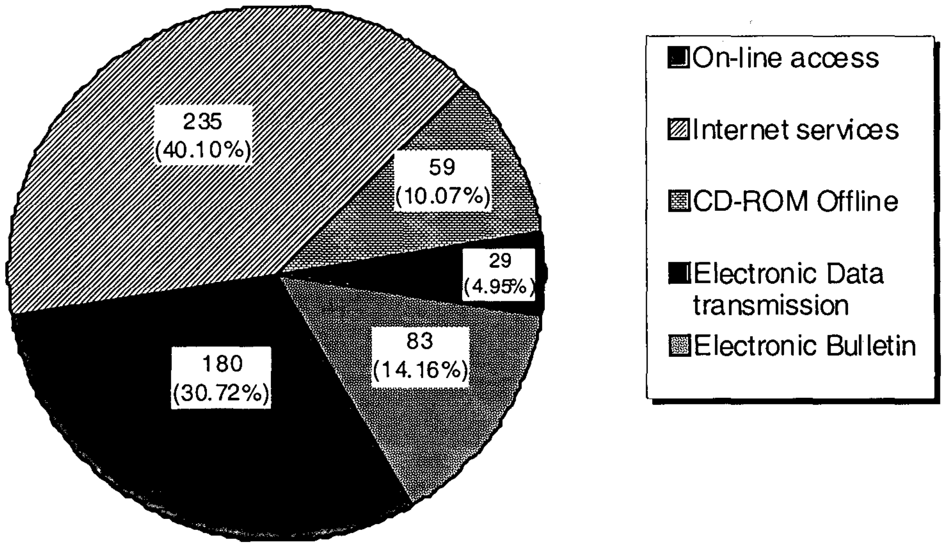

Table 4 - Comparison of extent of use of electronic information services among different levels of scientists & technologists

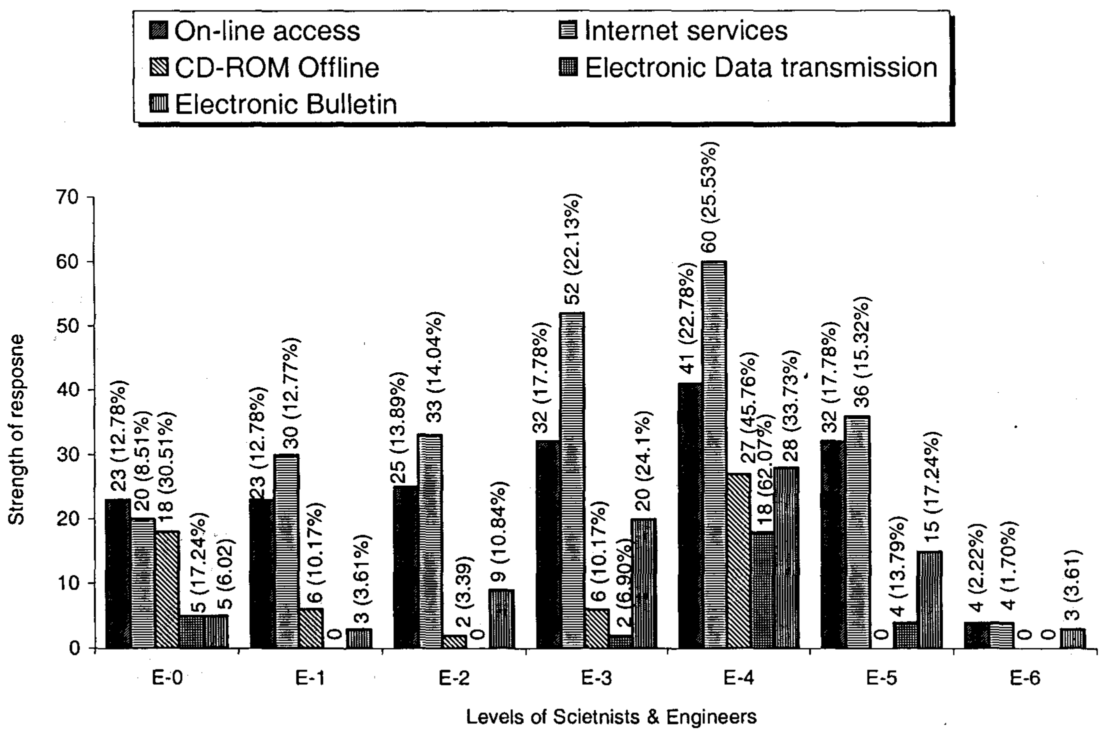

Fig. 5 - Status of use of library services in electronic formats among different levels of scientists & technologists

Table 4 - Comparison of extent of use of electronic information services among different levels of scientists & technologists

Sl. No.	Electronic information services	Levels of Scientists & Engineers						
		E-0 (N=71)	E-1 (N=62)	E-2 (N=69)	E-3 (N=112)	E-4 (N=174)	E-5 (N=87)	E-6 (N=11)
1.	On-line access(N=180)	23 (32.39)	23 (37.10)	25 (36.23)	32 (28.57)	41 (23.56)	32 (36.78)	04 (36.36)
2.	Internet services (N=235)	20 (28.17)	30 (48.39)	33 (47.83)	52 (46.43)	60 (34.48)	36 (41.38)	04 (36.36)
3.	CD-ROM Offline(N=59)	18 (25.35)	06 (9.68)	02 (2.90)	06 (5.36)	27 (15.52)	0	0
4.	Electronic Data transmission (N=29)	05 (7.04)	0	0	02 (1.79)	18 (10.34)	04 (4.60)	0
5.	Electronic Bulletin (N=83)	05 (7.04)	03 (4.84)	09 (13.04)	20 (17.86)	28 (16.09)	15 (17.24)	03 (27.27)

and technologists have responded its rare needs. The technologists group is also found enthusiastic in the electronic information resources at their work places with rising trend.

Use of electronic sources

The five categories of electronic information sources and services have been ranked as per its preferences of use being made by scientists and engineers. This is shown in Figure 4.

Of the total 586 respondents, 235 representing 40.10% prefer to use Internet services in the libraries. The use of Internet services by the respondents is followed by the services like, on-line access (30.72%), electronic bulletin (14.16%), CD-ROM offline (10.07%), and electronic data transmission services (4.95%).

The status of the use of library services in electronic formats among the various levels of scientists and technologists (E-0 to E-6) is further, explored and presented Fig. 5. It is seen that, of the 180 responses to 'on-line access', maximum percentage (22.78%) of users belong to E-4 level. The percentage of response from E-3 to E-5 levels is the same (17.78%), and E-0 and E-1 level are also having equal response regarding the use of 'on-line' access (12.78%). In case of use of 'Internet services', out of 235 responses, most of the users belong to E-4 level (25.53%), which is followed by E-3 level (22.13%), and then by E-5 level (15.32%) of scientists and engineers.

The top-level executives do not use the CD-ROM offline services. Out of 59 responses from this category, maximum percentage of users belongs to E-4 level (45.76%), which is followed by E-0 (30.15%) scientists and engineers. The services pertaining to 'electronic data transmission' are not of much use for E-1, E-2 and E-6 levels of scientists and technologists. Out of 29 responses received in this category, majority (62.07%) of users belongs to E-4 level, which is, further shown as less preferred by E-0 level (17.24%). Scientists and engineers at all levels invariably use the 'electronic bulletin services'. Out of the total 83 responses, most of the responses are seen from E-4 level (33.73%), which is, further followed by E-3 Level (24.1%).

A comparison is also made to find out the type of services used by different levels of scientists and engineers. (Table 4). Out of the total 71 respondents in E-0 level, on-line access service is highly preferred (32.39%) than other electronic services. But from E-1 to E-6 level, the 'internet services' are given focused priority over the preference of use of electronic sources. But when choice of specific service is compared, it is seen that 'on-line access' (37.01%) and Internet services (48.39%) are used to a large extent by E-1 level of scientists and engineers. However, the CD-ROM offline service is preferred by E-0 level (25.35%), and the electronic data transmission is much adopted by E-4 level (10.34%) of scientists and engineers.

The electronic bulletin is found to be much significant for E-6 level (27.27%) of scientists and the maximum percentage of responses for on-line access and Internet services are seen among E-4 level, but on comparison it is seen that these two services are substantially used by E-1 level of scientists and engineers. In case of CD-ROM offline services, although highest percentage, is also seen with E-4 level, but it is highly used by the E-0 level (25.35%). In case of electronic data transmission. E-4 level (10.34%) are the major users. But in case of the electronic bulletin of the total 11 respondents, it is used maximum (27.27%) by the executives in this level who mostly use electronic information. The use of electronic data transmission was found maximum with the levels E-3 to E-5. Electronic bulletin board is the most preferred access behavior of all the levels of respondents.

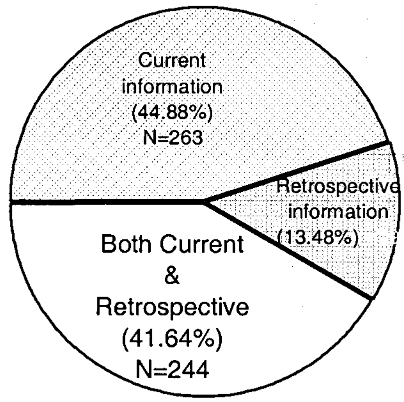

Table 6 - Currency of information needs

Current information needs vs retrospective needs Vs both current & retrospective information needs

The information needs of scientists and technologists such as current information needs, retrospective information needs, and both current and retrospective information needs is shown in figure 6. Among the different categories, majority of the scientists and technologists (44.88%) serving in the organization irrespective of their position, require current information. Information needs of 'retrospective' nature were found to be low (13.48%). About 42 % of the scientists and technologists were found to require both current and retrospective information (Fig. 6).

Further, the currency of information required at each level (E-0 to E-6) scientists and technologists is shown in Table 5. It reveals that out of 263 respondents who need current information, maximum (27.0%) executives belong to E-4 level; followed by E-3 (26.24%) level of scientists and technologists (Table-2). It may be added that among all, maximum of E-3 (19.64%) and then in E-4 (10.34%) (Table-1) scientists and technologists visit their libraries daily, perhaps to fulfill their current information needs.

Further, out of 79 respondents who are in need of 'retrospective' information, maximum (32.91%) scientists and technologists belong to E-4 level. Out of total 244 respondents who are in need of both retrospective and current information, maximum (31.56%) scientists and technologists also belong to E-4 level. When the frequency of nature of information needs among different levels of scientists and technologists was compared it was found that out of the total respondents from that level, maximum (66.67%) scientists and engineers of E-5 level require 'current' information (Table 6).

At the same time, out of total 11 scientists and engineers who belong to E-6 level, 9.09% of scientists and engineers belong to E-6 level who need both current and retrospective information and 36.36% of scientists and engineers of E-6 level are in need of only retrospective information (Table 3). Therefore, scientists and engineers of E-6 level mostly require either only current information (54.55%) or retrospective information (36.36%). However, the percentage of scientists and engineers of E-6 level intending to collect both types of information is almost negligible (9.09%). But scientists and engineers working at E-0 to E-2 level need maximum of both types of information—current and retrospective. Out of the total respondents, more than 50 percent of the respondents of E-0 (60.56%), E-1 (58.06%), and E-2 (50.72%) need both categories of information. However, the percentage of scientists and engineers at all levels requiring only retrospective information is quite less in comparison with the requirement of current and both current and retrospective types of information.

The senior most executives at level E-7 to E-9 being at the top always receive constant flow of current information from vertical movement through hierarchical structures of organization's organogram. It is also seen that scientists and technologists do not need only retrospective information rather they either depend on current information or both current and retrospective information.

Conclusion

Information is a vital element for research especially in the advanced areas like exploration and production business of oil and gas. The scientists and technologists engaged in such works are always in need of information for their day-to-day activities. So, these professional groups regularly use libraries for their information needs. The present study also concludes that information needs of scientists and technologists are directly related to their habit of library use. The scientists and technologists at the entry level need information at the frequency of fortnightly and monthly basis. But the executives working at a little higher position (i.e. E-1 to E-5 level) collect information frequently. The senior most executives of E-5 and above are found to have irregular information needs. Majority of the lower level executives especially in E-0 to E-4 need both current and retrospective information. The executives working in lower most level and top level are not in need of all sources of information where as the executives of the middle levels, i.e., from E-2 to E-5 are in need of almost all sources of information. With regard to the information needs of scientists and technologists in the electronic formats, maximum number of middle level executives (i.e., E-1 to E-4 executives) needs electronic databases. The factual databases are more needed among the higher-level executives (i.e., in E-3 to E-6 level) and directories in electronic form is only needed among the lower most executives (i.e., E-0 To E-2 executives). Therefore, scientists and technologists are in need of information available in electronic databases but their choice of database varies depending on cadres of job. Full text databases getting the top rank, are needed by maximum number of scientists and technologists, which are simultaneously preferred by maximum number of middle level executives (i.e., E-3 and E-4 executives). But the top level executives are interested in factual databases and the lower level executives are in need of directories in electronic format which got second and

Table 5 — Currency of information needs among different levels of scientists and technologists

S.No	Status of information needs	Levels of scientists & technologists						
		E-0	E-1	E-2	E-3	E-4	E-5	E-6
1.	Current(N=263)	18(6.84)	18(6.84)	23(8.75)	69(26.24)	71(27.0)	58(22.05)	06(2.28)
2.	Retrospective(N=79)	10(12.66)	08(10.13)	11(13.92)	09(11.39)	26(32.91)	11(13.92)	04(5.06)
3.	Current & retrospective (N=244)	43(17.62)	36(14.75)	35(14.34)	34(13.93)	77(31.56)	18(7.38)	01(0.41)

Figures in brackets give percentag

Table 6 — Comparison of frequency of currency of information needs among different levels of scientists & technologists

S. No	Status of information needs	Levels of scientists and engineers						
		E-0(N=71)	E-1(N=62)	E-2(N=69)	E-3(N=112)	E-4(N=174)	E-5(N=87)	E-6(N=11)
1.	Current	25.35%	29.03%	33.33%	61.61%	40.80%	66.67%	54.55%
2.	Retrospective	14.08%	12.90%	15.94%	8.04%	14.94%	12.64%	36.36%
3.	Current & retrospective	60.56%	58.08%	50.72%	30.36%	44.25%	20.69%	9.09%

third ranks respectively as per their floating needs among the scientists and technologists.

Electronic information services are obviously upcoming and endearing among all the executives irrespective of their disciplines and work environment. The on-line access services and Internet services are the two most popular library services in electronic formats. The scientists and technologists are now quite influenced by the electronic information. Therefore, the libraries of the organization must be well equipped with modern technology so that the information, which is generated inside and outside the organization must be collected, organized and data warehouses can be developed which may help every one in the organization to recycle the information.

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