FACTORS INFLUENCING CHINESE ELECTRONICS ENGINEERS' SELECTION OF INFORMATION SOURCES

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by

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The undersigned, appointed by the dean of the Graduate School, have examined the dissertation entitled

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ABSTRACT

Previous studies show that engineers prefer some information sources over others when they seek information for their work. Oral discussion, print textbooks, print handbooks and standards, online bibliographic databases, and print professional journals are among the top information sources engineers use. A number of factors, e.g., accessibility, ease of use and quality, have been found to be potential factors influencing engineers' information source use patterns.

However, previous studies are largely West-centered, and conducted in the pre-Internet age. This study endeavors to discover the information source use patterns of Chinese electronics engineers, and identify factors that influence their selection of information sources. An online survey has been conducted among the engineering subscribers of a Chinese magazine in the electronics industry. Descriptive statistics, correlations and factor analysis are employed for data analysis.

The online survey generated 1,164 usable valid responses. Results show that subjects in this study prefer online information sources over traditional ones. Vertical websites seem to be taking the place of traditional periodicals. In addition, Chinese subjects do not favor

discussion as their Western peers do; they prefer non-human information sources better than inter-personal communication.

Subjects' selection of information sources are correlated with a number of elements, but at most moderately. Factor analysis demonstrates that EASE is the only noticeable principal component affecting subjects' use of information sources. The effect of QUALITY is merely detectable.

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CHAPTER 1: RATIONALE FOR THE STUDY

1.1 Overview

This chapter introduces the research conducted for the dissertation and explains the rationale for conducting the research. It includes a statement of the problem, the purpose of the study, statement of research questions, and significance of the study.

This study explores Chinese electronics engineers' information-seeking behavior. It concentrates particularly on the examination of factors that influence Chinese electronics engineers' selection of information sources. The research design is based on the findings of previous research conducted outside of China. One reason is the lack of similar studies using Chinese subjects. The other reason is that engineers around the world are regarded as having much in common; they share a unique body of knowledge, and a unique way of communicating (Tenopir & King, 2004).

Although the West (Europe, North America and Oceania) accounts for 17% of the world's population, most of human information behavior research has been conducted in the Western world. In contrast, Asia accounts for more than 60% of the world's population, but it has received limited attention from information scientists. This research is expected to alleviate the situation that human information behavior study has largely been West-centered. Results of the study could serve as a foundation for future research comparing Chinese and Western electronics engineers' information-seeking behavior as well as guidance for improvement of information services to Chinese electronics engineers.

1.2 Statement of the Problem

To date, research on human information behavior has been heavily West-centered. Most studies in the field were conducted under the context of Western culture. Very limited literature can be found on subjects from non-Western cultures. The situation is in sharp contrast with today's reality of world information consumption and production.

China has been undergoing momentous economical development. It is now a nation that consumes enormous amounts of information. An example of China's information consumption scale is the size of its Internet population. According to the report by China Internet Network Information Center (CNNIC), released in January 2008, China had 210 million Internet users by the end of 2007 (CNNIC, 2008). This number is only five millions less than that of the United States and increasing at a faster rate.

This study concentrates on a special group of subjects: Chinese electronics engineers. Specifically, this study expects to uncover the patterns of Chinese electronics engineers' information source use, and the underlying factors that affect this user group's selection of information sources.

Chinese electronics engineers are selected as subjects for study for a number of reasons:

- The Chinese electronics engineers' information environment is different from that of their Western peers;
- The Chinese culture is distinctively different from that of the West;
- The role of Chinese electronics engineers is becoming increasingly important to the world's economy;
- Chinese electronics engineers, like their Western counterparts, are heavy information consumers;
- Chinese electronics engineers are representative of, in a sense, East Asian engineers who share the same Confucian culture; and
- Chinese electronics engineers have so far received little attention from information science researchers.

Chinese electronics engineers live in an environment significantly different from that of their Western peers. Because the country's economy was less developed in the past, the availability of traditional information facilities, such as public libraries, is very limited. In 2005, China's public library per capita spending on books was less than RMB 0.30, or 4 U.S. cents, and national average book ownership in public libraries is less than 0.3 per capita (Liu, 2006). Although urban areas enjoy better service than rural areas, public libraries are still in short supply. However, due to the recent rapid economic growth, China now owns a widespread modern information infrastructure. Access to newer means of communications, such as the Internet and mobile phones, is widely available. As a result, Chinese people are more likely to adopt modern media because competition from traditional media is relatively weaker. This unique information environment may produce different patterns of information source use.

Chinese electronics engineers are of significant research value to information scientists. Chinese electronics engineers have now become an important and growing workforce of the world economy, and their performance affects the quality of our daily life. For more than two decades, the world's electronics production has been moving from the West to China. According to *the The Yearbook of World Electronics Data, volume 2 - America, Japan & Asia Pacific 2007* (2008), China surpassed the United States as the world's largest electronics producer in 2006. For work purposes, Chinese electronics engineers need enormous amounts of information. Shorter electronic product lifecycle and tighter lead-time to market, ever-more-complicated product design, higher end-user expectations, fiercer competition and lower profit margin, all put great pressure on the work of electronics engineers. On all stages, from concept development to production line maintenance, electronics engineers need large amounts of timely information to keep up with the latest technical development. According to a 2007 survey among the users of 21IC.com, a leading vertical website targeting Chinese electronics engineeers, 86 percent of the participants reported that their job required them to continue to learn new things (McClenahan Bruer Communications, 2007).

On the other hand, China's electronics engineers are inundated with information. According to the researcher's professional experience in the industry since 1998, information available to Chinese engineers has increased dramatically during the last decade. Ten years ago they had few technical magazines to subscribe to, and the World Wide Web was not widely available. Five years ago they had several technical magazines to choose from, and online sources became an alternative. Today they are offered more technical magazines than they can read, and free Internet contents become the engineers' first choice for their work-related information needs.

In sum, Chinese electronics engineers are a unique information user group, they are an important part of the world's workforce, and they are intense information consumers, but they have been largely ignored by information behavior researchers. In addition, Chinese engineers deserve more attention because they are representative of, in a sense, a larger user group.

1.3 The Purpose of the Study

This study is an effort to uncover two aspects of Chinese electronics engineers' information behavior: the patterns of Chinese engineers' use of available information sources for their work, and the factors that affect their use of these information sources.

Chinese engineers, like their Western peers, have many information sources to choose from when they need information to support their work. They do not treat these information sources equally; they prefer some information sources over others, and their preferences change over time. Electronics engineers, in particular, may exhibit their own patterns of information source use. This study tries to identify the patterns and factors that constitute their patterns of source use.

Knowing the reasons why electronics engineers prefer some information sources over others is important. Literature on this subject is comparatively abundant for general information users. One typical theoretical work, is Zipf's Principle of Least Effort, which maintains that humans choose the method which consumes their least-expected effort to solve a problem. A number of scholars in the field of information science have applied this theory to the study of information retrieval (e.g. Bierbaum, 1990; Gratch, 1990; Mann, 1993). Empirical works also exist to explore factors affecting humans' information source preference in specific settings, such as research conducted by Hardy (1982), Anderson, Glassman, McAfee, and Pinelli (2001), and Gerstberger and Allen (1968). However, no work has been done using Chinese electronics engineers as a subject group. This study is an effort to fill the gap. In addition, the findings of this study provides recommendations and suggestions for information service professionals, giving them insights on how to provide better service to this important user group.

1.4 Statement of the Research Questions

The nature of this study is descriptive and exploratory. It focuses on the following two general research questions:

1 What are the patterns of Chinese electronics engineers' work-related information source use?

2 What factors correlate with Chinese electronics engineers' work-related information source use?

The first research question comprises of the following sub-questions:

1a. At what frequencies do Chinese electronics engineers use various information sources for their work?

1b. For what specific purposes do Chinese electronics engineers use each information source?

The second research question comprises of the following sub-questions:

2a. For each information source, which factors correlate significantly with the source's use frequency?

2b. For all information sources, which factors correlate significantly with overall use frequency?

1.5 Research Method

This research tries to examine characteristics of Chinese electronics engineers' information source selection, and describes the relationship among a set of variables. The research method is descriptive, multifactorial correlational, and predictive correlational.

The research method employed in this study is an online survey. An online questionnaire serves as the data collection instrument. Participants are engineering subscribers of *Electronic Products China*, a technical trade magazine targeting Chinese electronics engineers. The magazine maintains a circulation database with detailed information of more than 40,000 Chinese electronics engineers. The invitation letter was sent via email to all the engineering subscribers who provided valid email addresses.

Collected data was analyzed with a number of statistical techniques. Correlations between information source use and each potential element were calculated to identify significant factors. Factor analysis was conducted to find principal components that affect Chinese electronics engineers' information source selection.

The design of the study takes into consideration both theoretical and empirical previous studies. Theoretical frameworks such as Zipf's Principle of Least Effort are used as references to shape up research questions. Empirical studies using subject groups from other countries/areas are used as references for both research question formation and data collection instrument composition. In addition, internal user studies conducted by the researcher's company of employment and other organizations also helped to shape the research design.

1.6 Significance of the Study

Findings of the study have both theoretical and practical implications. From the academic perspective, this study helps to further understand the information behavior of an under-represented user group. It enriches the literature on Asian respondents, building a foundation for future research in this area of the world. In addition, this study investigates the use of online information sources and reveals the current status of information source use by this particular professional user group. This study can also serve as a basis to discuss theories on human information behavior.

From the practical perspective, findings of the study help practitioners in the information industry to better understand the information-seeking behavior of Chinese electronics engineers and Chinese engineers in general. The study could serve as a basis for the development of better information systems and services to this user group.

1.7 Summary

Previous work on human information behavior research has been mostly West-centered. The amount of research conducted among Chinese professional user groups is rather limited. This study focuses on an important non-Western user group - Chinese electronics engineers. Chinese electronics engineers' use of various information sources are be uncovered, and factors influencing their selection of information sources are examined. The research can serve as a basis for further studies on this user group. The research generates recommendations for practitioners in the information industry to improve their service to Chinese electronics engineers.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

This chapter reviews literature related to the research questions of this study and builds a foundation for the research design. The literature review focuses on previous studies on engineers' information-seeking behavior, particularly on information sources engineers use, engineers' source use, and factors influencing engineers' information source selection.

2.2 Engineers' Information-Seeking Behavior

Engineers are among the earliest user groups studied by information scientists. Research on engineers' information behavior dates back to early 1960s (e.g., Gerstberger & Allen, 1968; Allen & Cohen, 1969; Rosenberg, 1967; Davis, 1966). In more than four decades, abundant literature has been accumulated, covering various aspects of the engineering profession concerning information gathering and use.

The book by Tenopir and King (2004), *Communication Patterns of Engineers*, systematically and comprehensively summarizes and analyzes the research on how engineers communicate. This book covers engineers' communication frameworks, the importance of information to the engineering profession, engineers' information seeking and use, factors affecting engineers' seeking as use, and other topics less related to this research. This literature review does not attempt to cover Tenopir and King's broad scope.

Rather, it concentrates only on information sources engineers use and factors affecting engineers' source selection.

2.2.1 Engineers' Information Sources and Their Use

Several related terms have been used in the literature, sometimes without clear definition: information source, information channel, and information carrier. For example, Johnson, Donohue, Atkin, and Johnson (1995) used the term "information carrier," which encompasses message, source, and channel. This research uses the term "information source," referring to any outlet from which people get information.

To serious information seekers, selecting the right information sources is important. The nature of an information source often defines the quality of the information retrieved from that source, and ultimately affects the quality of the decision which is made based on the information gathered. For example, Cohen and Levinthal (1990) found that the most innovative firms appear to be those that are best at recognizing the relevance of new, external information. Other scholars found that internal sources are also important for innovation (e.g., Allen, Lee, & Tushman, 1980; Goldhar, Brawag, & Schwartz, 1979).

Engineers use many information sources. Scholars often label and categorize these information sources differently. Table 1 shows a partial list of information sources found in the literature categorized as oral/written and internal/external. Table 2 shows information sources categorized as oral/written and formal/informal. Information sources can also be categorized as synchronous/asynchronous, on-site/remote, people/document, etc.

Table 1

Information sources categorized as oral/written and internal/external

	Internal (within organization)	External (outside organization)
Oral	▪ Speaking with coworkers or other people inside my organization ▪ Speaking with a librarian or technical information specialist	▪ Speaking with colleagues outside my organization (e.g., customers and the vendors, technological suppliers and persons in the same line of business)
Written	▪ Consulting my personal store of knowledge including sources I keep in my office (personal collections) ▪ Internal technical reports	▪ Conference papers ▪ Journals ▪ Public technical reports

Table 2

Information sources categorized as oral/written and formal/informal

	Informal	Formal
Oral	▪ corridor talks ▪ impromptu visits ▪ cafeteria talks ▪ telephone conversations	▪ presentations at conferences ▪ attending classes ▪ staff meetings ▪ committee meetings ▪ contractor meetings brainstorming sessions
Written	▪ e-mail ▪ letters ▪ memos ▪ proposals	▪ scholarly articles ▪ trade journals ▪ professional books ▪ internal and external reports ▪ patent documents

Some of the qualitative studies reviewed reveal very detailed events (e.g., corridor talks) where information exchange occurs. It is crucial to discover information sources most frequently used by engineers which account for a large portion of their total information input. Israeli scholars Yitzhaki and Hammershlag (2004) provide valuable information in this regard. Table 3 shows a list of Israeli engineers' information sources ranked by use in the beginning of a project. Table 4 shows sources used in the middle of a project (Yitzhaki & Hammershlag, 2004). Oral discussion with colleagues, experts, or supervisors within the organization and print text books are among the most popular information sources in both the beginning and middle of a project. On the other hand, information sources such as printed letters and printed trade/promotional literature were not preferred by Israeli engineers.

Table 3

Ranked ratios of information sources to obtain initial information

Information Sources	Format	%	Rank
Discussion with colleagues/experts in the organization	Oral	68	1
Bibliographic databases	Internet	54	2
Textbooks	Printed	52	3
Discussion with supervisors	Oral	49	4
Handbooks and Standards	Internet	47	5.5
Professional journals	Printed	47	5.5
Letters	Internet	46	7
Handbooks and standards	Printed	45	9
In-house technical reports	Printed	45	9
Discussion with experts outside your organization	Internet	45	9
Librarians and information specialists	Internet	39	11
Conference/meeting papers	Printed	38	12
Trade/promotional literature	Internet	36	13
Textbook	Internet	35	14
Professional journals	Internet	32	15.5
Conference/meeting papers	Internet	32	15.5
Government technical reports	Internet	31	17
Librarians and information specialists	Printed	26	18.5
Discussion with experts outside your organization	Oral	26	18.5
In-house technical papers	Internet	25	20.5
Bibliographic databases	Printed	25	20.5
Discussion with colleagues/experts in the organization	Internet	23	22.5
Trade/promotional literature	Printed	23	22.5
Discussion with supervisors	Internet	20	24
Letters	Printed	18	25.5
Government technical reports	Printed	18	25.5

Source: Yitzhaki & Hammershlag, 2004

Table 4

Ranked ratios of information sources in mid-project

Information Sources	Format	%	Rank
Discussion with colleagues/experts in the organization	Oral	76	1
Textbooks	Printed	65	2
Handbooks and standards	Printed	57	3
Discussion with supervisors	Oral	55	4
Handbooks and Standards	Internet	54	5
Professional journals	Printed	51	6
Discussion with experts outside your organization	Internet	47	7
Bibliographic databases	Internet	44	8.5
Letters	Internet	44	8.5
In-house technical reports	Printed	39	10
Conference/meeting papers	Printed	38	11
Professional journals	Internet	33	12
In-house technical papers	Internet	32	15
Discussion with colleagues/experts in the organization	Internet	32	15
Textbook	Internet	32	15
Conference/meeting papers	Internet	32	15
Librarians and information specialists	Internet	32	15
Discussion with experts outside your organization	Oral	31	18
Trade/promotional literature	Internet	26	19
Government technical reports	Internet	23	20
Discussion with supervisors	Internet	22	21
Trade/promotional literature	Printed	18	23
Bibliographic databases	Printed	18	23
Librarians and information specialists	Printed	18	23
Letters	Printed	17	25

Source: Yitzhaki & Hammershlag, 2004

Information sources available to engineers change with the development of information technology. Compared with other previous research, the work by Yitzhaki and Hammershlag (2004) has significant reference value to this research because it investigated many most up-to-date Internet-based information sources. A series of studies on engineers conducted by King Research and the University of Tennessee from 1986 to 2001 is also noticeable. The studies yielded the estimates of engineers' reading activity as shown in Table 5. Scholarly journal articles rank first, followed by internal reports, trade journals/bulletins, other books, professional books, external reports, and patent documents. Unfortunately, the list contains written sources only; it does not include other information sources such as the Internet. Most of other previous studies bring up a limited number of information sources and some of them are too old to be meaningful today.

Table 5

Average annual amount of documents read by engineers by type: U.S. 1986-2001

Type of Document	Readings	%
Scholarly journal articles	83	32.8
Internal reports	73	28.4
Trade journals/bulletins	47	18.3
Other books	26	10.1
Professional books	14	5.4
External reports	8	3.1
Patent documents	6	2.3

Derived from Tenopir & King, 2004

Engineers use different information sources under different circumstances and for different purposes. For example, external information is used to reduce technical uncertainty and complexity (Miller, 1971). Engineers make heavy use of internal communication to keep up-to-date (Ellis & Haugan, 1997). Oral sources are preferred when dealing with non-routine, ambiguous, difficult messages, while written sources are selected when dealing with routine, clear, simple messages (Daft & Lengel, 1984; Lengel & Daft, 1988; Dirsmith & Covaleski, 1985). Engineers may search for written sources to find people sources, and search for people sources to get written sources (Hertzum & Pejtersen, 2000).

2.2.2 Factors influencing engineers' use of information sources

Engineers today have many information sources to choose from. For decades, information researchers have been studying what influences engineers' decisions on source selection. These studies generated both some consistent and also some conflicting findings, covering a number of potential factors that may influence engineers' source selection.

Effort

Effort needed to use an information source is the most frequently cited factor. Virtually all studies support the notion that spending least effort is a primary principle that governs engineers' information source use. Anderson et al. (2001) concluded that engineers prefer oral sources over written sources because the former consumes less of their effort. In general, Hardy (1982) suggested that people take a path of least resistance when seeking information rather than focusing primarily on quality. A number of other studies (e.g., Badawy, 1988; Allen, 1977; Blandin & Brown, 1977; Culnan, 1983; Gertsberger & Allen, 1968; Hardy, 1982; O'Reilly, 1982; Rosenberg, 1967; Swanson, 1987) also support this conclusion.

Anderson et al. (2001) found that users' sequential order of information source selection followed a pattern consistent with the George Zipf's Principle of Least Effort. That is, respondents preferred personal collections and oral communications within the organization; the next choice was to confer with others outside the organization. A lesserused choice was to refer to the literature, and the last choice was to consult with library intermediaries.

Gerstberger and Allen (1968) further examined the concept of “effort.” Based on previous studies, they found two aspects of effort: psychological and physical. To assess the psychological effort they measured the ease of use of an information source, and to assess the physical effort they measured accessibility. Ease of use and accessibility of an information source together defines effort needed to use that information source.

Accessibility

Accessibility is often regarded as an important factor influencing the selection of information sources, and has been investigated by many scholars over the time (e.g., Allen, 1977; Culnan, 1983, 1985; Gertsberger and Allen, 1968; O’Reilly, 1982). Leckie, Pettigrew, and Sylvain (1996) considered accessibility as the most dominant factor in the use of information sources. Allen and Gerstberger (1967) found that, for engineers, a direct relationship exits between perceived accessibility of information sources and several objective measures of utilization, whereas no definite support was found for the relationship between technical quality and frequency of usage. A number of studies have found that engineers have a heavy reliance on the more accessible oral communication for transfer of information (e.g., Allen & Cohen, 1969; Jain & Triandis, 1990). Ellis and Haugan (1997) stated that engineers spent more time in personal contact than in reading and that engineers turned first to the channel that was most accessible. Yitzhaki and Hammershlag (2004) concluded that the accessibility factor had only a partial effect on information sources used in practice. The study by Anderson et al. (2001) even proved that accessibility is not a factor in written source use. Marton and Choo (2002) found no significant relationship between source accessibility and source usage for women Information Technology professionals in Canada. Blados, Pinelli, and Kennedy (1990) found that accessibility has less influence over the use of an information source than reliability and relevance.

However, scholars often measure accessibility with various dimensions. For example, Gerstenfeld and Berger (1980) measured the sheer amount of time spent searching for information. Pinelli, Bishop, Barclay, and Kennedy (1993), on the other hand, interpret accessibility as the physical distance between the engineer and the information source. Other scholars just use the term without further elaboration.

To solve the problem of lack of common definition on the concept of accessibility among researchers, Fidel and Green (2004) turned to the subjects for an answer. Through in-depth interviews with 32 engineers, they concluded that the concept of accessibility comprises document format, level of detail, amount of information in one place, familiarity with the source.

Ease of use

Various authors have investigated the factor "ease of use" (Gertsberger & Allen, 1968; Hardy, 1982; Rosenberg, 1967). A number of information sources are found to be preferred by engineers because of their ease of use, including personal collections, informal communication, physically accessible sources (Von Seggern, 1995), personal knowledge and experience (Leckie et al., 1996), and internal communications and direct communication (Ellis & Haugan, 1997).

A person's prior use/familiarity with an information source contributes to its ease of use. Information seekers are more likely to obtain information from sources familiar to them rather than to seek from sources they have never tried, and this practice becomes self-reinforcing (March & Simon, 1958; Allen, 1977). Non-users of a particular information source are likely to underestimate the usefulness of the source and to overestimate the difficulty of obtaining desired information from that source (Wilson, 1977). The notion that successful prior use of an information source is a factor in information-seeking behavior was also upheld by Culnan (1985), Hardy (1982), Johnson et al. (1995), Johnson (1996), and Swanson (1987). Leckie et al. (1996) concluded that accessibility and familiarity are more important than perceived quality.

Quality

Source quality is another factor investigated by many authors (e.g., Allen, 1977; Gertsberger and Allen, 1968; O'Reilly, 1982; Hardy, 1982; Anderson et al., 2001). Gerstberger and Allen (1968) found that an information source's technical quality was unrelated to its use. Anderson et al. (2001) also concluded that for U.S. aerospace scientists and engineers, quality was not a factor in written source use. Through an empirical study of the information behavior of US Forest Service professionals, Hardy (1982) suggested that quality is a factor affecting the selection of information sources, although not as strongly as accessibility. This finding is consistent with Hirsh and Dinkelacker (2003), who found that authoritativeness and currency did matter for some researchers at Hewlett Packard's labs.

Trustworthiness is another concept closely related to quality. Two empirical case studies conducted by Hertzum et al. (2002) demonstrate that software engineers devote a lot of attention to considerations about the trustworthiness of their information sources, and they normally know their information sources first-hand or have them recommended by colleagues. In another paper, Hertzum (2002) argued that trust is of central importance because quality is a perceived property, and thus assessing the quality of information source is essentially a matter of establishing to what extent one is willing to place trust in it.

The consideration of trustworthiness may help to explain engineers' preference of internal information sources. Hertzem and Pejtersen (2000) stated that engineers get most of their information from colleagues and internal reports, both of which they have confidence on trustworthiness. Trust is particularly important in security-related institutions such as aerospace research and development. Surveys conducted by Blados et al. (1990) confirm that information external to the aerospace organization tends to be used less than internal sources of information.

Perceived importance, relevance and utility

Perceived importance, relevance and utility are three interrelated concepts found to be significantly affecting engineers' information source selection. Through factor analysis, Anderson et al. (2001) identified a factor which they defined as "perceived importance." This factor was the primary determinant when engineers choose from written information sources. Swanson (1987) studied the dispositions of 186 users of ten management information systems in four organizational settings. This analyzed 38 factors and identified a factor he termed "value," which included the attributes of importance, relevance, meaningfulness, usefulness and value. The value dimension was found significant, but not the primary determinant of the use of a source. Johnson et al. (1995) adopted Evans and Clarke's (1983) concept of "salience," or "the perceived applicability of information to a problem that he or she faces." In a multivariate analysis, these authors found that 'importance' was one of several factors included in their comprehensive model.

Task Characteristics

Characteristics of tasks engineers are performing may affect the information sources they use. Despite differences in definitions and theoretical approaches over time, the literature provides considerable evidence showing that increased task complexity and task uncertainty lead to greater use of multiple sources. Anderson et al. (2001) found that as task uncertainty increased, the engineers' search widened from oral contacts to literature searches and, then, to consulting with library personnel. However, they concluded that task complexity was not a factor in source selection order, and task complexity and task uncertainty were not major factors in written source election.

Katz and Tushman (1979) studied task characteristics in research and development settings and found task complexity and uncertainty are related to project type. Overall, task complexity is highest with basic research projects, followed by applied research and development. Table 6 lists levels of complexity and uncertainty by project type.

Table 6

Levels of complexity and uncertainty by project type

Type of project	Complexity	Uncertainty
Research	3.88	3.52
Development	3.85	3.43
Management	3.69	3.06
Production	3.68	3.24
Design	3.60	3.01
Education	3.15	2.69

Source: Katz & Tushman (1979)

Demographics

Although many studies describe the demographic composition of subjects, no convincing evidence has been found to relate demographics to the use of information sources. Demographics are often not considered as a major factor in information seeking and not treated as focus of analysis (e.g., Anderson et al., 2001).

Project Phase/Stage

Engineers' information-seeking behavior changes through different stage of a project. By studying the information-seeking patterns of engineers and research scientists in a Norwegian oil and gas company, Ellis and Haugan (1997) found that information seeking was most extensive in the initial phase of a project, involving both formal and informal sources. Engineers became increasingly selective as they progressed to advanced phases of the project. The use of formal sources decreased as they progressed in the project, and person to person communication became dominant. In the final phase, however, both formal and informal sources were again utilized, but on a smaller scale. The information activities in this stage were mainly in the form of a small literature search or through contacts with knowledgeable people in the field to supplement the information already gathered.

Geographical factor

Tenopir and King (2004) performed a comprehensive review of literature regarding the effects of geographic and culture differences on engineers' information seeking and use.

The literature covers the United States, European countries, and Asia countries. They concluded that engineers around the world are more alike than different, but differences do exist.

One of the biggest differences is the availability of technology. Tenopir and King claimed that if technology access is optimized and equalized, the similarities across engineers around the world may far outweigh any cultural or geographic differences. However, this conclusion is unconvincing because the vast majority of studies that could be found are conducted within the context of Western cultures. Similarities seem to be more evident among engineers of the Western culture. For example, a study of university faculty in the United Kingdom and Czech Republic found differences in how they used paper information systems, but no differences in how they used electronic personal information management systems (Jones & Thomas, 1999). Not surprisingly, engineers in the developed West share more similar information behaviors. O'Flaherty (1997) pointed out that aerospace engineers across Western Europe "have similar information-seeking habits" and all are increasingly using the Internet. They also have a more positive attitude toward electronic access to information than in the past. Harrington and Blagden (1999) found that European aerospace engineers are experiencing information overload similar to their counterparts in the United States.

Differences are often found in non-Western countries. For example, Lalitha (1995) found that engineers in India are not able to attend many professional conferences due to financial constraints. In Saudi Arabia, university engineering faculty have significant difficulty acquiring all of the information they need, including delays in getting journals, outdated book collections, and lack of help in locating the information since libraries are not as well equipped as those in the U.K. (Al-Shanbari & Meadows, 1995).

Literature on The NASA/DOD Aerospace Knowledge Diffusion Research Project, which involved engineers from multiple countries, provides insights into the differences between Asian and U.S. engineers. A Phase 4 activity of this project surveyed aerospace engineering professionals and students in India, Japan, the Netherlands, Russia, and the United Kingdom. Although aerospace engineers from different nations demonstrated far more similarities than dissimilarities, Asian engineers did show some different information-seeking patterns compared to their American counterparts. Both Indian and Japanese aerospace engineers used libraries much more than American engineers, while a greater number of Americans used electronic networks (Blados et al., 1990).

Summarizing the literature above, the factors closely related to this study are listed in Table 7, with description by each author. These factors are further investigated in this research among Chinese electronics engineer subjects.

Table 7

Factors affecting the selection of information source summarized

Factors	Description and reference
Accessibility	• The ease of getting to the information source (Pinelli et al., 1991) • Most RELIABLY available, no waits or hassles (Dinkelacker, 2003) • Is accessible (Fidel & Green, 2004) • Is available (Fidel & Green, 2004)
Ease of Use	• The ease of comprehending or utilizing the information (Pinelli et al., 1991) • How easily the channel can be used to access information you want (Hardy, 1982) • Most CONVENIENT at time/place of my choosing (Dinkelacker, 2003)
Expense	• Low cost in comparison to other information sources (Pinelli et al., 1991)
Familiarity or Experience	• Prior knowledge or previous use of the information source (Pinelli et al., 1991) • Most FAMILIAR, "tried and true," has worked for me in the past (Dinkelacker, 2003) • Sources I know

Table 7 (continued)

Technical Quality or Reliability	• The information was expected to be the best in terms of quality, accuracy and reliability (Pinelli et al., 1991) • Most AUTHORITATIVE, gives the most reliable, complete information (Dinkelacker, 2003) • Is reliable (Fidel & Green, 2004)
Comprehensiveness	• The expectation the information source would provide broad coverage of the available knowledge (Pinelli et al., 1991) • Can give the right level of detail (Fidel & Green, 2004)
Relevance	• The expectation that a high percentage of the information retrieved from the source would be used (Pinelli et al., 1991) • How much useful information the channel provides (Hardy, 1982) • Can give data that meets the needs of the project (Fidel & Green, 2004) • Is most likely to have the information needed (Fidel & Green, 2004)
Physical Proximity	• The distance to the information source (Pinelli et al., 1991) • Is physically close (Fidel & Green, 2004)

Table 7 (continued)

Skill In Use	• The level of skill or skill mastery required to use the information source (Pinelli et al., 1991)
Timeliness	• The time allocated or available to produce a solution (Pinelli et al., 1991)
Time-Saving Ability	• How much a channel can save you time by providing you needed information (Hardy, 1982) • Least TIME to track down (Dinkelacker, 2003) • Saves time (Fidel & Green, 2004) • How much time it takes to deliver the information (Hardy, 1982)
Selectivity	• How precise the channel is in weeding out exactly the information you want (Hardy, 1982)
Format	• Has the right format (Fidel & Green, 2004)

2.3 Related Theories

Unlike natural sciences, social sciences often lack of "paradigms" as defined by Thomas Kuhn in his influential book *The Structure of Scientific Revolutions*. In library and information science, there is no dominant theory to guide research and practice. As Case (2002) pointed out, most studies of information seeking and use make no explicit claim to theories. This study is not be confined by any particular theory either. However, a review of relevant theories helps to shape the design of the research.

2.3.1 Principle of Least Effort

The theory most relevant to information source selection is George K. Zipf's Principle of Least Effort. Zipf proposed his grand theory in human behavior in his 1949 book *Human Behavior and the Principle of Least Effort.* The Principle of Least Effort, often referred to as Zipf's Law, was built upon the works of earlier experimental psychologists. Among them are Gengerelli's *Principle of Maxima and Minima in Learning*, Tsai's *Laws of Minimum Effort and Maximum Satisfaction in Animal Behavior,* and Waters' *Principle of Least Effort in Learning* (Zipf, 1949).

Zipf's original definition of the Principle of Least Effort is

> *And yet what is this Principle? In simple terms, the Principle of Least Effort means, for example, that a person in solving his immediate problems will view these against the background of his probable future problems,* ***as estimated by himself****. Moreover he will strive to solve his problems in such a way as to minimize the* ***total work*** *that he must expend in solving* ***both*** *his immediate problems* ***and*** *his probable future problems. That in turn means that the person will strive to minimize the* ***probable average rate of his work-expenditure*** *(over time). And in doing so he will be minimizing his* ***effort****, by our definition of effort. Least effort, therefore, is a variant of least work.* (Zipf, 1949, p. 1)

Zipf's Law was adopted by library and information science scholars early in the 1960s (e.g., Harris, 1966; Rosenberg, 1966, 1967; Allen & Gerstberger, 1967; Buckland & Hindle, 1969). Rosenberg (1966) surveyed attitudes of scientists in industrial and governmental environments, and inferred "that the ease of use of an information gathering method is more important than the amount of information expected." Allen and Gerstberger (1967) also studied scientists as information seekers, and concluded that scientists' criteria for information source selection directly relates information sources' accessibility, and that no definite relation is found between information sources' utilization and their technical quality. Harris (1966) examined students' use of university library resources, and found that physical accessibility is determinative to their frequency of use.

Later works in information science continued to support Zipf's Law. Allen's 1977 study of engineers revealed that frequency of use was more related to information sources' accessibility than their quality. Chen and Hernon (1982) also wrote of strong preferences among information-seekers for interpersonal sources. Dervin (1983) found that people tend to rely on close friends and relatives (information sources of ease of use) for their information. Salasin and Cedar (1985) surveyed 1,666 researchers, practitioners, and policymakers in the field of rural mental health services and conclude that information resources tend to be chosen on the basis of perceived ease of use, rather than on the basis of the amount of information expected from the source. As Zipf's Law gaining momentum in the field, a number of authors in the 1990s began to recommend it as paradigm of the discipline (e.g., Bierbaum, 1990; Gratch, 1990; Mann, 1993).

2.3.2 Opportunistic Acquisition of Information

Information behavior research has traditionally focused on purposive acquisition of information. In recent years, however, the phenomenon of opportunistic discovery of information has drawn scholars' attention. Opportunistic acquisition of information is equivalent, in a sense, to serendipity in scientific discoveries, which have taken place in the fields of physics, biology, chemistry, astronomy, medicine, and even archaeology (Roberts, 1989). These discoveries are found serendipitously, i.e., they were not actively sought, but proved to be valuable resources once uncovered.

Erdelez introduced the concept of information encountering in 1997. She proposed that information encountering is affected by characteristics of information user, characteristics of the information environment, and characteristics of encountered information. She also classified four groups of information users: super-encounterers, encounterers, occasional encounterers, and non-encounterers(Erdelez, 1997). Information encountering enriches conceptualization of other frameworks of information behavior, such as the Principle of Least Effort: through information encountering, users are rewarded even when there is no apparent investment of effort to search for some information.

2.4 Summary

Literature on engineers' information behavior is abundant. Research dates back to the 1960s, mostly conducted in the Western world. Various empirical studies uncover many kinds of information sources and their use: external and internal, formal and informal, oral and written. Engineers have preference for some information sources over others in various situations. The most frequently used information sources include discussion with colleagues/experts in the organization, textbooks, discussion with supervisors, handbooks and standards, bibliographic databases, professional journals, etc.

Many factors have been identified that may potentially influence engineers' selection of information sources. Effort needed to use an information sources, often measured in terms of accessibility and ease of use, is most frequently cited by scholars. Other factors include quality, perceived importance and relevance, task characteristics such as uncertainty and complexity, demographics, and phase/stage of the project.

Literature shows that information behavior differences do exist among engineers of different cultural backgrounds, though engineers around the globe share considerate commonalities. Research on subjects with the unique East Asia culture is rather limited.

George Zipf's Principle of Least Effort is regarded as the most applicable to this research. Some factors identified by information researchers as having influence upon subjects' information source selection, such as accessibility and ease of use, are closely related to Zipf's concept of "effort." Understanding Zipf's Law helps to shape the research design, and the theory can serve as a foundation for discussion at the end of the dissertation.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Overview

This chapter discusses the design of the study, participants, development of the instrument, data collection, and data analysis methods. Survey research is employed to answer the research questions defined in Chapter 1. Participants were recruited from Chinese electronics engineers who subscribed to an industry trade magazine. An online questionnaire served as the data collection instrument. Data analysis includes descriptive statistics, correlation calculation, and principal component analysis.

3.2 Design of the Study

The research design was created based on the purposes of the study. In other words, the research design aims to answer the following research questions brought up in Chapter 1:

1. What are the patterns of Chinese electronics engineers' work-related information source use?
2. What factors correlate with Chinese electronics engineers' work-related information source use?

The first research question comprises of the following sub-questions:

1a. At what frequencies do Chinese electronics engineers use various information sources for their work?

1b. For what specific purposes do Chinese electronics engineers use each information source?

Research question 1a tries to identify the most frequently used information sources by Chinese electronics engineers. Research question 1b tries to uncover the reasons Chinese engineers use each information source (e.g., for latest technological development, new product information, design information, and application information). The findings are important for information providers to service the right kind of information through different media. For example, engineers may use print magazine primarily for new product information.

The second research question comprises of the following sub-questions:

2a. For each information source, which factors correlate significantly with the source's use frequency?

Chapter 2 summarized factors that may have influence upon engineers' information source selection, e.g., accessibility, ease of use, information quality. However, for each information source, the governing factors may be different. For example, for online information sources, ease of use may prevail; for print sources, quality may be the overriding factor. Answer to this question helps to understand why subjects prefer some information sources to others, and the justification of some information sources' popularity or existence.

2b. For all information sources, which factors correlate significantly with overall use frequency?

This research question examines factors that have influence upon Chinese electronics engineers' information source use in general. Each information source is not investigated separately; data collected for all information sources are collapsed to identify factors significantly related to information source use. In other words, correlation was checked between use frequency of all information sources and each potential element.

In addition, principal components were derived from above-mentioned elements. A number of principal components that contribute to subjects' information source selection were identified. Through factor analysis, the number of factors can be reduced. This method has been employed by a number of related previous studies. For example, Hardy's 1982 empirical study analyzed the information behavior of U.S. Forest Service professionals. SPEED of acquiring information and CONTENT of the information sources were derived as principal components. The Kaiser criterion (Kaiser, 1960) was used to decide the number of principal components extracted. The researcher retained only factors with eigenvalues greater than 1.

This study employed an online survey for a number of reasons. Compared with other research methods, an online survey has several advantages. The ability to reach a large number of subjects and generate a large amount of quantitative data are among top considerations for this study. Other advantages of an online survey include low cost, high controllability and short return cycle.

Compared with other research methods, an online survey is perhaps most cost-effective because it incurs no postal or print cost. The researcher also has more control over sampling. For example, it is simple to select subjects who are involved in product design and development. In addition, an online survey minimizes the possibility of false respondents, because people rarely give others access to their computers or email accounts.

3.3 Participants in the Study

The research used *Electronic Products China*'s circulation database as the target population. *Electronic Products China* is a monthly technical publication targeting Chinese electronics design engineers and engineering managers, providing them with up-to-date product and technology information. The publication is circulated in mainland China and published in simplified Chinese. The researcher is the magazine's editorial director.

Using *Electronic Products China* magazine's circulation database, which contains detailed information of more than 40,000 readers, the researcher expected to get 1,000 respondents through online survey. Past experience showed that the subject group responds to online surveys actively. For example, over 1,400 subscribers participated in an online survey conducted by *Electronic Products China* in January 2007. The HTML format questionnaire included in an email was sent to 20,000 design engineers who subscribed to the magazine. The return rate was over seven percent.

Sample size is the first thing to consider if a research wishes to generalize research findings to the whole population. The exact number of Chinese electronic engineers is unknown, with estimates ranging from 150 thousands to over one million. Such a large population size required a considerate sample size to ensure confidence level and precision level. Using common calculation formulas such as Cochran's (Cochran, 1963), a sample size of 1,000 was needed in order to achieve 95% confidence level and 3% precision level.

The ultimate population in this study was all Chinese electronics engineers. However, as in most cases, the researcher does not have access to the whole population. What the researcher had access to was a group of Chinese electronics engineers who opted to subscribe to the magazine *Electronic Products China*. Although this user group cannot fully represent all Chinese engineers, this research built a foundation for future investigations. The researcher complied with all Institutional Review Board (IRB) requirements for human subject research.

An email invitation letter with a link to the online survey was sent out to 20,000 engineering subscribers of *Electronic Products China* on March 27, 2008. The researcher did not track how many subscribers opened the email. Past experience showed that email messages could not reach all target recipients. The actual open rate was around 15 percent. Thus roughly 3,000 subscribers had the opportunity to respond to the survey. By closing date, a total number of 1,374 subjects responded. The gross response rate before data screening (the number of respondents divided by the total number of invitations sent) was 6.87%. The net response rate before data screening (the number of respondents divided by the number of people who opened the invitation email) should be around 46%. The sample size dropped slightly after data screening, explained in detail in section 3.6. After the data-screening process the overall number of valid responses was 1,164.

Some respondents dropped out while they proceeded with the survey. Whenever a respondent completed one or more entire sections, the response could be considered valid. The total valid response rate was 5.82%. Response rate for each section declined gradually. The last section received the least number of responses. After data screening, the response rate for the last section was 1.11%. Table 8 shows the overall sample size and response rate as well as for the last section.

Table 8

Sample size and response rate

	Overall	Last Section
Sample Size before Screening	1,374	405
Response Rate before Screening (%)	6.87	2.03
Sample Size after Screening	1,164	222
Response Rate after Screening (%)	5.82	1.11

3.4 Development of the Instrument

The data collection instrument for this study was an HTML format online questionnaire. A Web developer of *Electronic Products China* helped the researcher to create an online survey system to collect data. A letter of invitation with a link to the online questionnaire was sent via email to the selected subjects described above.

In order to maximize validity, questionnaire items were created mostly based on authoritative previous studies, e.g., the NASA/DoD Aerospace Knowledge Diffusion Research Project. The selection of both information sources and the potential elements influencing source use takes into consideration of previous studies. To further guarantee the face validity of the data collection instrument, the researcher conducted three face-to-face pilot surveys before the large-scale online survey.

3.4.1 Variables/elements measured

Based on the research questions listed in Chapter 1 and the literature review in Chapter 2, this study explored Chinese electronics engineers' information source use patterns, and the correlation between use frequencies of information sources with a set of elements. The elements investigated in this study are those found to be significantly related to source use in previous studies.

Elements around which questions were asked are listed in Table 9. Each element or variable was measured by one question, paraphrased when necessary. The purpose was to maximize instrument validity, and at the same time minimize the number of questions asked in order to guarantee response rate.

Table 9

Elements examined in this study

Elements	Questions asked
Accessibility/Availability	Getting to the information source is very easy. It is very reliably available.
Ease of Use	Getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize.
Familiarity or Experience	I know this information source; it worked for me in the past.

Table 9 (continued)

Technical Quality or Reliability	Information from this source is authoritative. It is the best in terms of quality, accuracy and reliability.
Comprehensiveness	The information source provides broad coverage of available subject knowledge. Information retrieved from this source is complete with adequate detail.
Relevance	This information source provides lots of useful information that often meets the needs of the project. I often use a high percentage of the information retrieved from this source. It is most likely to have the information I need.
Physical Proximity	The distance to the information is close.
Skill in Use	The information source does not require much skill to use.
Time-Saving Ability	Using the information source can save my time. It delivers needed information quickly. Tracking down information using this source takes little time.
Selectivity	The information source can precisely weed out other information and gives me exactly the information I want.
Format	The information source provides me with information/data with the right format
Information Encountering	Using this information source, I often accidentally come across useful information

The last item was included to measure "information-encountering coefficient," to remedy the insufficiency of studies on opportunistic information acquisition. It attempts to find out how Chinese electronics engineers use each information source as a channel for information encountering.

3.4.2 Information sources investigated

The selection of information sources investigated was based on two considerations. One consideration is the result of literature review in Chapter 2 which revealed the most important information sources found in previous studies. Most notable is the work of Yitzhaki and Hammershlag, (2004), which ranked a thorough list of information sources used by Israeli engineers, as shown in tables 3 and 4. The other consideration is the findings of internal reader studies conducted by *Electronic Products China*. Some information sources listed by previous studies were not included because they are outdated, such as printed bibliographic databases and written letters. More online information sources were included as a result of rapid adoption of information technology in recent years.

Table 10

A list of candidate information sources investigated in this research

Information Sources	Format
Textbooks	Print
Conference/meeting papers	Print
Industry directory, reference guide, handbooks, standards and data source	Print
In-house technical reports	Print
Professional journals, industry/trade publications	Print
Trade/promotional literature	Print
Discussion with experts outside your organization	Online forums or chats
Discussion with supervisors, colleagues/experts in the organization	Online forums or chats
Bibliographic databases	Online
Conference/meeting papers	Online
Industry directory, reference guide, handbooks, standards and data source	Online
In-house technical reports	Online
Seminars, exhibitions and conferences	Online
Component providers' websites	Online
Government technical reports	Online

Table 10 (continued)

Industry/vertical websites	Online
Any web page retrieved using search engines	Online
Discussion with experts outside your organization	Face-to-face
Discussion with supervisor, colleagues/experts in the organization	Face-to-face
Seminars, exhibitions and conferences	Face-to-face
Discussion with experts outside your organization	Email
Discussion with supervisor, colleagues/experts in the organization	Email
Trade/promotional literature	Email

Table 10 lists 23 potential information sources investigated in the research. However, in order to maximize response rate, not all of the 23 information sources were investigated. If the survey questionnaire asked questions regarding each of the 23 information sources, it might take too long for the participants to complete. Under the concern of possible low return rate, the researcher took the measure of a pre-research evaluation on information source use before the construction of the final questionnaire.

The pre-research survey was conducted among 21IC.com's forum users, from February 15 through 28, 2008. 21IC.com is a vertical portal site serving China's electronics industry, with most of its users working as engineers or engineering managers. The website's forums attract about 20,000 visitors on a typical workday.

The researcher put a post to the forums with a link to an online questionnaire, inviting the users to participate in the survey. The questionnaire listed all of the 23 candidate information sources. Subjects were asked to select the sources they use frequently. Multiple selections were permitted. (See Appendix F for the questionnaire.) A total number of 176 subjects participated in the survey during the timeframe. Table 11 shows the result of the survey. The results are also illustrated in the form of bar chart in Figure 1 in descending use frequency order.

Table 11

Results of the pre-research survey among 21IC.com's forum users

Source	Format	Cases	%
Any web page retrieved using search engines	Online	140	79.55
Textbooks	Print	123	69.89
Bibliographic databases	Online	110	62.50
Discussion with experts outside your organization	Online forums or Chats	106	60.23
Component providers' websites	Online	99	56.25
Industry directory, reference guide, handbooks, standards and data source	Online	72	40.91
Discussion with supervisors, colleagues/experts in the organization	Face-to-face	70	39.77
Industry/vertical websites	Online	70	39.77
Professional journals, industry/trade publications	Print	67	38.07
Industry directory, reference guide, handbooks, standards and data source	Print	62	35.23
In-house technical reports	Online	51	28.98
Seminars, exhibitions and conferences	Face-to-face	49	27.84

Table 11 (continued)

Discussion with supervisor, colleagues/experts in the organization	Online forums or chats	48	27.27
Discussion with experts outside your organization	Email	47	26.70
In-house technical reports	Print	47	26.70
Conference/meeting papers	Online	44	25.00
Trade/promotional literature	Print	42	23.86
Discussion with experts outside your organization	Face-to-face	39	22.16
Discussion with supervisor, colleagues/experts in the organization	Email	34	19.32
Seminars, exhibitions and conferences	Online	33	18.75
Trade/promotional literature	Email	32	18.18
Conference/meeting papers	Print	19	10.80
Government technical reports	Online	14	7.95

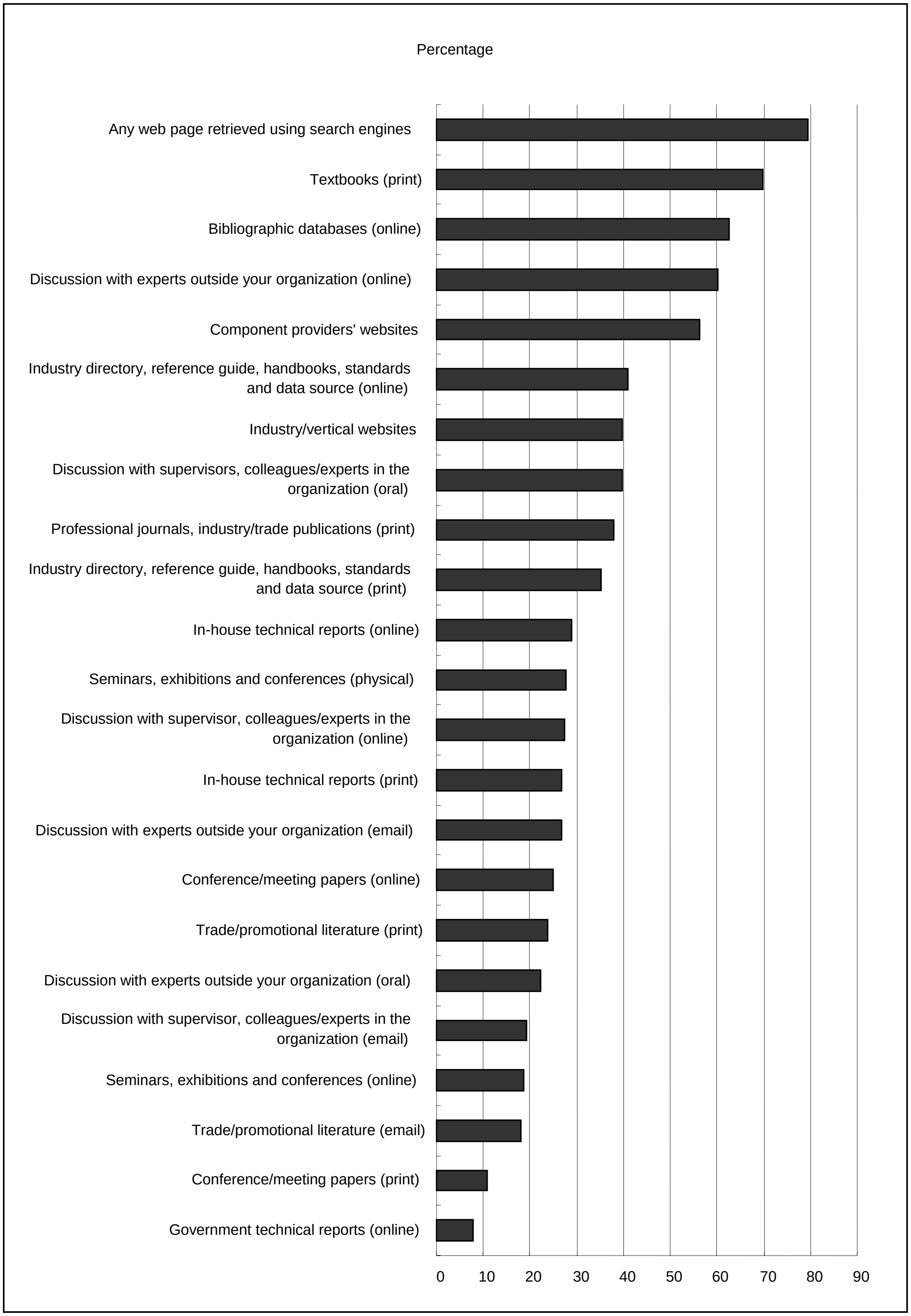

Figure 1. Results of the pre-research survey among 21IC.com users illustrated

The purpose of this survey was to select information sources for the final survey. Selection of information sources had two criteria: considerate use frequency and source format. In other words, the selected information sources should be used frequently by Chinese engineers, and the list of information sources should cover various formats (i.e., print, online/web, face-to-face, and online/forums or chats). Inclusion of the most-frequently used information sources not only helped to investigate the most important sources, but also helped to increase response rate. Inclusion of all source format helped to study engineers' patterns of source use.

Considering both of the above-mentioned criteria, the researcher identified a balance point of 25 percentage of use (25% participants reported that they use the information source frequently). Information sources with use percentage greater than 25% were selected to be included in the final survey, as shown in the following Table 12. A total number of 15 sources were selected, covering all formats of information sources: four print sources, two online forums/chats, six web sources, two face-to-face sources, and one email source. Print sources include textbooks, industry directory, reference guide, handbooks, standards and data source, in-house technical reports, professional journals, and industry/trade publications. Online chat or forum sources include discussion with experts outside the organization and discussion with supervisor, colleagues/experts in the organization. Online sources include bibliographic databases, industry directory, reference guide, handbooks, standards and data source, in-house technical reports, component providers' websites, industry/vertical websites, and any web page retrieved using search engines. Face-to-face sources include discussion with supervisors, colleagues/experts in the organization, and seminars, exhibitions and conferences. The email source included is discussion with experts outside the organization.

Table 12

Information sources for the final survey

Source	Format	Cases	%
Textbooks	Print	123	69.89
Industry directory, reference guide, handbooks, standards and data source	Print	62	35.23
In-house technical reports	Print	47	26.70
Professional journals, industry/trade publications	Print	67	38.07
Discussion with experts outside your organization	Online forums or chats	106	60.23
Discussion with supervisor, colleagues/experts in the organization	Online forums or chats	48	27.27
Bibliographic databases	Online	110	62.50
Industry directory, reference guide, handbooks, standards and data source	Online	72	40.91
In-house technical reports	Online	51	28.98
Component providers' websites	Online	99	56.25

Table 12 (continued)

Industry/vertical websites	Online	70	39.77%
Any web page retrieved using search engines	Online	140	79.55%
Discussion with supervisors, colleagues/experts in the organization	Face-to-face	70	39.77%
Seminars, exhibitions and conferences	Face-to-face	49	27.84%
Discussion with experts outside your organization	Email	47	26.70%

3.5 Data Collection

An online survey questionnaire served as the data collection instrument. The questionnaire consists of two major sections:

- Section 1 asked participants how frequently they use each of the above-mentioned 15 information sources. Subjects were asked how frequently they use each information source, ranging from "always/routinely" (with a score of 4) to "never" (with a score of 0).
- Section 2 asked detailed questions regarding each information source when a participant answered that she or he uses that source. The participants were asked to evaluate a series of statements, in a five-level Likert scale from strongly disagree (with a score of -2) to strongly agree (with a score of +2).

  A five-level scale was used instead of a seven-level scale because the researcher considered that five-level would be sufficient for the purpose of this study. In addition, a symmetry scale around a neutral middle point with equal spacing of response levels clearly indicated helps to generate interval data.

The original questionnaire was composed in Chinese language. Section 1 of the original questionnaire is shown in Appendix D. The English language translation is shown in Appendix E.

An email invitation letter with a link to the HTML questionnaire was sent to *Electronic Products China* magazine's engineering subscribers. The survey ended three weeks after the invitation letter was sent. Collected data were saved automatically to a Microsoft Access database.

3.6 Data Screening and Analysis

A data-screening procedure was needed prior to the data analysis activities. Major data issues in this study include inaccurate data and missing data. Because the sample sizes are large enough to generate significant findings as shown in Chapter4, data screening was simply in the form of data deletion. Data deletion involved the deletion of seven percent of incomplete and suspicious data. After data cleaning, the number of responses was still large enough for the intended data analysis. Outliers do not apply because all data are generated by the online survey system; participants could not enter data with values beyond the pre-defined range.

3.6.1 Deletion of incomplete records (missing data)

Missing data emerged when participants opted to complete only part of the questionnaire. This is normally not a problem as long as a participant finishes a complete section of the questionnaire and submits a complete dataset (record). However, when a participant fails to complete a section, the value of the dataset decreases. When less than half of the questions in a section are answered, the value of the dataset becomes questionable, because the participant might not be serious answering the questions.

Researchers usually have three options when dealing with missing data. Option 1 is to delete cases with missing value. The disadvantage of this approach is reduction of sample size. Option 2 is leaving the data as is. During data analysis process, the researcher can apply listwise deletion or pairwise deletion to treat missing values. Option 3 is to replace missing values with through mean substitution or regression substitution. Apparently option 2 and 3 cannot solve the researcher's concern on respondents' seriousness. Taking option 1 would result in significant sample size reduction and loss of valuable data. In order to ensure data quality and at the same time keep sample size reasonable, the research would be compromised by deleting datasets with more than 50% empty fields.

3.6.2 Deletion of suspicious records (inaccurate data)

For anonymous online surveys, participants' sincerity and honesty may have an impact on the accuracy of the data collected. In this study, the researcher suspects that some of the participants did not answer questions seriously. A number of datasets were found problematic. For example, all fields in one dataset had the same value. The respondents might have selected the options casually. To minimize the effect of the inaccurate data, the researcher decided to delete all records with the same value in all fields.

After the data screening process, the number of records regarding information source use frequency decreased 15.3 percent. The total number of records regarding detailed questions on each information source decreased 26.2 percent. Table 13 shows record numbers before and after data screening. Table 14 shows the sample size for detailed questions on each information source after data screening.

Table 13

Record numbers before and after data screening

	Use frequency Question	Detailed Questions re Sources
Before Screening	1,374	7,481
After Screening	1,164	5,521
Deduction rate	15.3%	26.2%

Table 14

Sample size for detailed questions on each information source

Source	Format	N	RRE
Component providers' websites	Online	882	76%
Discussion with supervisors, colleagues/experts in the organization	Face-to-face	584	50%
Discussion with experts outside your organization	Email	435	37%
Any web page retrieved using search engines	Online	429	37%
Industry/vertical websites	Online	343	29%
Seminars, exhibitions and conferences	Face-to-face	328	28%
Textbooks	Print	325	28%
Industry directory, reference guide, handbooks, standards and data source	Print	313	27%
Discussion with supervisor, colleagues/experts in the organization	Online forums or chats	296	25%
Professional journals, industry/trade publications	Print	287	25%
Bibliographic databases	Online	283	24%
Discussion with experts outside your organization	Online forums or chats	276	24%
Industry directory, reference guide, handbooks, standards and data source	Online	260	22%
In-house technical reports	Print	257	22%
In-house technical reports	Online	222	19%

3.6.3 Data analysis

Data after the cleaning process were analyzed to answer each previously stated research questions. Descriptive statistics, correlation calculation, and factor analysis methods were employed to answer the research questions. Results are presented in Chapter 4.

3.7 Validity and Reliability

Validity and reliability are two major aspects concerning research quality. Validity refers to the degree to which a study presents the concepts that the researcher attempts to measure. Reliability is concerned with the accuracy of the actual measuring instrument or procedure (Kerlinger, 1964).

3.7.1 Validity

Researchers are concerned with both external and internal validity. External validity refers to the extent to which the results of a study can be generalized to a larger population. Findings of this study are valid to subscribers of *Electronics Products China* and all Chinese electronics engineers who share the same demographic characteristics and information environment with the survey respondents. Results of the study can not be applied to other user groups without further research.

Internal validity refers to the rigor with which the study is conducted. Scholars often discuss the following types of internal validity: face validity, criterion-related validity, construct validity, and content validity.

Face validity is concerned with how valid a measure or procedure appears (Trochim, 2001). It does not depend on established theories for support. In this study, face validity was maximized by utilizing the results of previous studies, including findings through interviews (e.g., Fidel & Green, 2004) and measurement items of classical studies (e.g., Anderson at al., 2001).

To further guarantee the face validity of the data collection instrument, the researcher conducted three face-to-face pilot surveys before the large-scale online survey. Modifications were made where participants showed difficulty in answering the questions. For example, respondents of the pilot survey had difficulty understanding the term "vertical websites." The researcher modified the term to "specialized websites in the electronics industry." This ensures that the participants understand the questions in the way that the researcher intended.

Criterion-related validity is used to demonstrate the accuracy of a measure or procedure by comparing it with another measure or procedure which has been demonstrated to be valid (Trochim, 2001). Construct validity seeks agreement between a theoretical concept and a specific measuring device or procedure. These two types of validity are not major issues in this study because the research employed commonly used Likert scale to measure variables. In other words, this study does not measure theoretical constructs such as “accessibility.”

Content validity is based on the extent to which a measurement reflects the specific intended domain of content (Trochim, 2001). Content validity is a critical issue of questionnaire design. In this study, content validity has been maximized by taking into account all measurements in previous studies pertaining to a concept to be measured. Chapter 2 presented a comprehensive summary of dimensions for each concept. In addition, inter-item correlations were calculated to evaluate actual content validity.

3.7.2 Reliability

The most relevant reliability concern is internal consistency, which deals with the extent to which survey items in a questionnaire measure the same attribute (Trochim, 2001). In this study, the correlation among each set of variables was calculated. The researcher found no variables that have low correlation with the group. The result shows that the survey items kept satisfactory internal consistency.

Stability reliability (or test, re-test reliability) does not apply to this study because this is not a longitudinal study. Inter-rater reliability, or the extent to which two or more individuals (coders or raters) agree, does not apply either.

3.8 Summary

This chapter provides rationale for the selection of the research method, description of prospect participants, criteria for the data collection instrument, and data analysis process for answering the research questions.

CHAPTER 4: RESULTS

4.1 Overview

This chapter analyzes the data collected through the online survey, and answers the research questions first brought up in Chapter 1. Descriptive statistics were collected to find out the patterns of subjects' information source use. Use frequency of each information source was calculated and listed. Subjects' purposes of using each information sources were identified. Correlations between the use frequency of each information source and a list of elements were shown. Factor analysis is performed among relevant variables.

4.2 Sample Characteristics

Reader surveys conducted by a number of information service organizations in the industry (e.g. *Electronic Products China*, *EDN China*, 21IC.com) show that Chinese electronics engineers are typically young males. The median age is around 30, and males account for more than 95% of the population. The findings of this study confirm the findings of these reader surveys. Figure 2 below illustrates the age structure of the 1,164 respondents. The majority is below 35 years old, and the mode is 26 to 30.

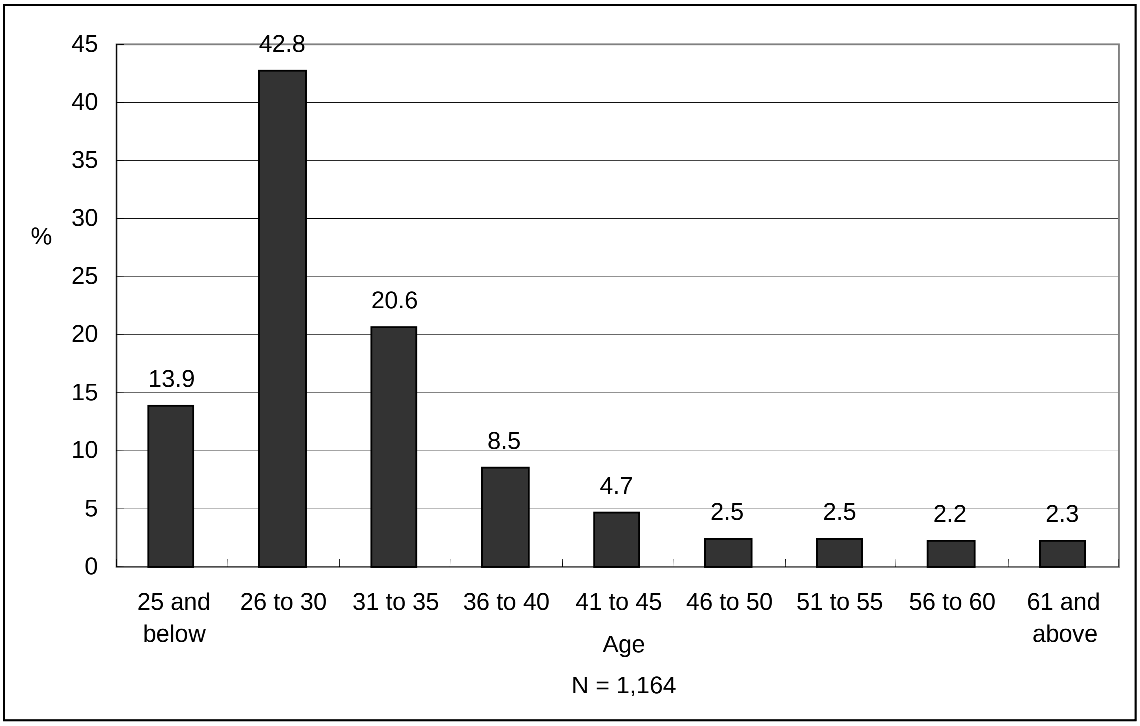

Figure 2. Respondents' age structure

4.3 Results for Research Question 1

The first research question (what are the patterns of Chinese electronics engineers' work-related information source use) is descriptive in nature. To address research question 1a ("At what frequencies do Chinese electronics engineers use various information sources for their work?"), the mean value of the use frequency for each information source was calculated. The means of top 10 sources are listed in Table 12 in descending order to demonstrate subjects' information source use. A frequency distribution bar chart is also drawn to represent the results visually. To address question 1b ("For what specific purposes do Chinese electronics engineers use each information source?"), bar charts are generated to illustrate subjects' purpose using each information source.

4.3.1 Source use frequency

Research question 1a attempts to reveal Chinese electronics engineers' use frequencies of various information sources. Subjects were asked how frequently they use each information source, ranging from "always/routinely" (with a score of 4) to "never" (with a score of 0).

On average, subjects use the listed information sources from "occasionally" to "frequently." Frequency mean of the least-used information source (seminars, exhibitions and conferences) is 2.03, and the mean of the best-used source (Any web page retrieved using search engines) is 3.20.

However, for all information sources, subject's use frequency distribution is rather dispersed. Although the sample size is well over 1,000, the standard deviations of use frequency for each information source range from 0.66 to 1.08, with a mean of 0.84.

Three information sources are used "frequently" by an average user. They are any web page retrieved using search engines, industry/vertical websites, and face-to-face discussion with supervisors, or colleagues/experts within the organization, with frequency means of 3.20, 3.10, and 2.94, respectively. Table 15 shows top 10 most frequently used information sources in descending order. Figure 3 shows the distribution visually.

Table 15

Top 10 most frequently used information sources

Source	Format	N	Mean Freq.	Std. Deviation
Any web page retrieved using search engines	Online	1164	3.20	0.71
Industry/vertical websites	Online	1160	3.10	0.66
Discussion with supervisors, colleagues/experts in the organization	Face-to-face	1161	2.94	0.80
Textbooks	Print	1169	2.86	0.73
Bibliographic databases	Online	1164	2.83	0.68
Component providers' websites	Online	1158	2.81	0.73
Professional journals, industry/trade publications	Print	1140	2.73	0.70
In-house technical reports	Print	1147	2.52	0.84
Industry directory, reference guide, handbooks, standards and data source	Print	1159	2.49	0.83
Industry directory, reference guide, handbooks, standards and data source	Online	1128	2.49	0.83

(Note: 0 = never, 1 = rarely, 2 = occasionally, 3 = frequently, 4 = routinely/always)

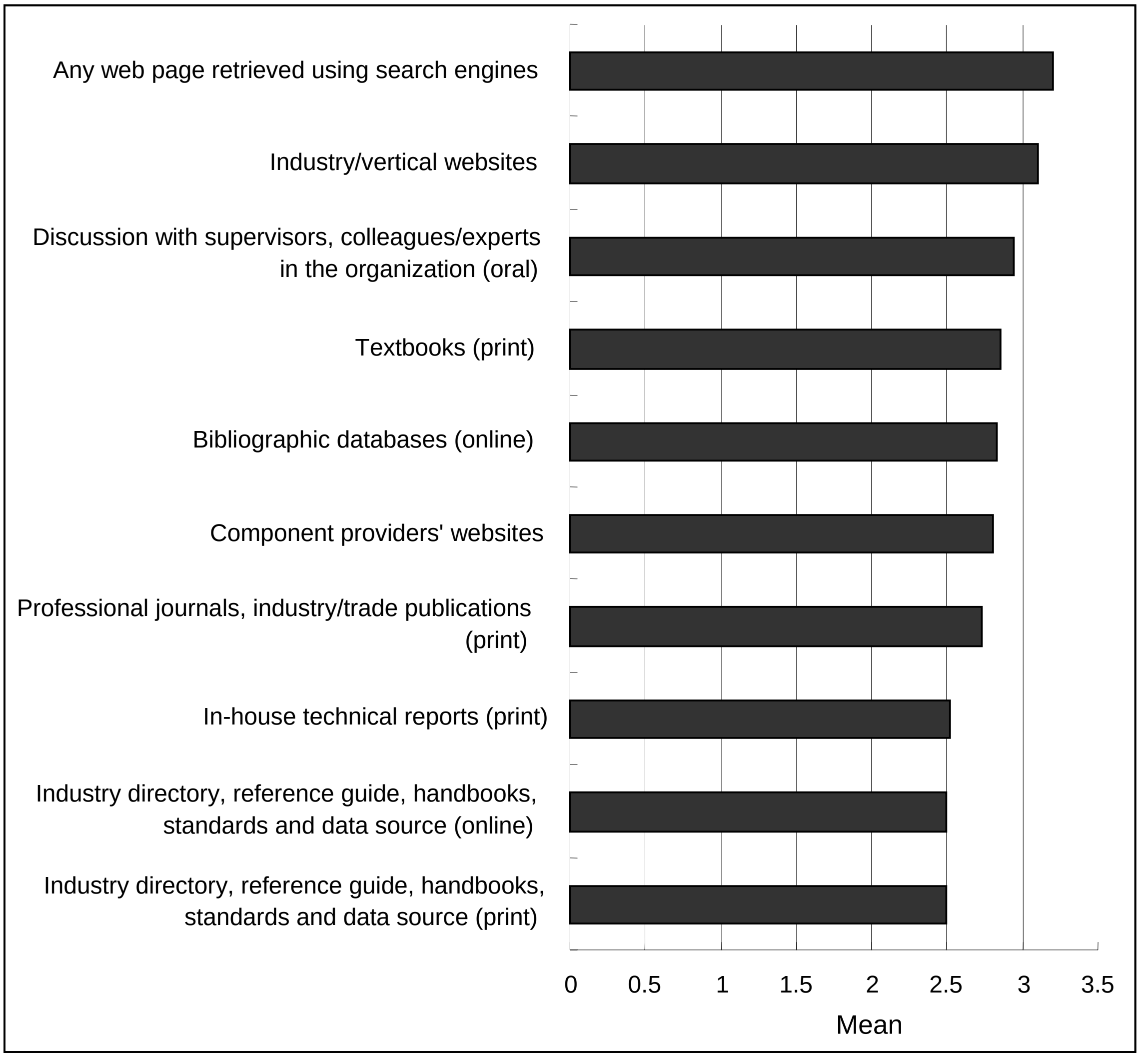

Figure 3. Use frequency means of top 10 information sources

(Note: 0 = never, 1 = rarely, 2 = occasionally, 3 = frequently, 4 = routinely/always)

When the information sources are grouped by type, i.e. Web, print, face-to-face, email, and online forums or chats, it is obvious that subjects prefer some types of sources over others. Personal information sources, i.e. Web and print, are more preferred than inter-personal communications, i.e. face-to-face, email, and online forums or chats. Among personal information sources, Web is preferred over print. Among inter-personal information sources, face-to-face method is best preferred. Communication via online forums is found to be less favored than face-to-face method and email. Table 16 and Figure 4 shows the use frequency mean of each source type.

Table 16

Use frequency means of five types of information sources

Format	N	Relative Response Rate (%)	Mean Frequency
Web	10394	99	2.57
Print	6904	99	2.49
Face-to-face	3481	100	2.45
Email	3463	99	2.34
Online forums or chats	2309	99	2.23

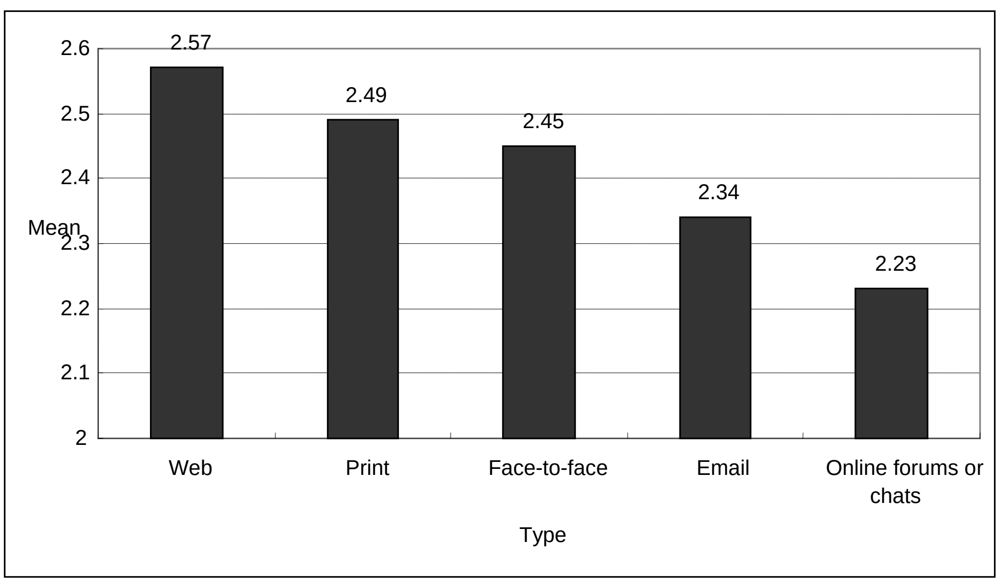

Figure 4. Use frequency means of five types of information sources

(Note: 0 = never, 1 = rarely, 2 = occasionally, 3 = frequently, 4 = routinely/always)

4.3.2 Purposes using each information source

Research question 1b expected to find out the specific purposes Chinese electronics engineers use each information source. Participants were asked five reasons for using each information source: for information on latest technological developments, for information on new products, for design information, for application information, and for any useful information they encounter. Results are shown in Figure 5 through Figure 9. Statistics are listed in Table 17 through Table 21. (RRE stands for relative response rate, the ratio of the number of responses for a specific question to the total number of 1164 valid responses)

For information on latest technological development, subjects notably prefer industry/vertical websites, component providers' websites, professional journals, industry/trade publications, seminars/exhibitions/conferences, and any web page retrieved using search engines. They may also use other information sources except textbooks. Textbooks get a negative value, showing subjects do not consider textbooks as an information source for product information.

Table 17

Statistics for information source use on latest technological development information

Source	Mean	N	RRE	Std. Dev.
Industry/vertical websites	0.85	339	29%	0.66
Component providers' websites	0.74	864	74%	0.80
Professional journals, industry/trade publications	0.70	283	24%	0.79
Seminars, exhibitions and conferences	0.68	316	27%	0.83
Any web page retrieved using search engines	0.58	418	36%	0.94
Industry directory, reference guide, handbooks, standards and data source	0.42	257	22%	0.99
Bibliographic databases	0.42	277	24%	1.04
Industry directory, reference guide, handbooks, standards and data source	0.34	302	26%	1.01
Discussion with experts outside your organization	0.32	422	36%	0.97
Discussion with experts outside your organization	0.31	266	23%	1.03
Discussion with supervisors, colleagues/experts in the organization	0.24	570	49%	1.08
Discussion with supervisor, colleagues/experts in the organization	0.23	288	25%	1.02
In-house technical reports	0.23	214	18%	1.06
In-house technical reports	0.16	254	22%	1.07
Textbooks	-0.18	320	27%	1.23

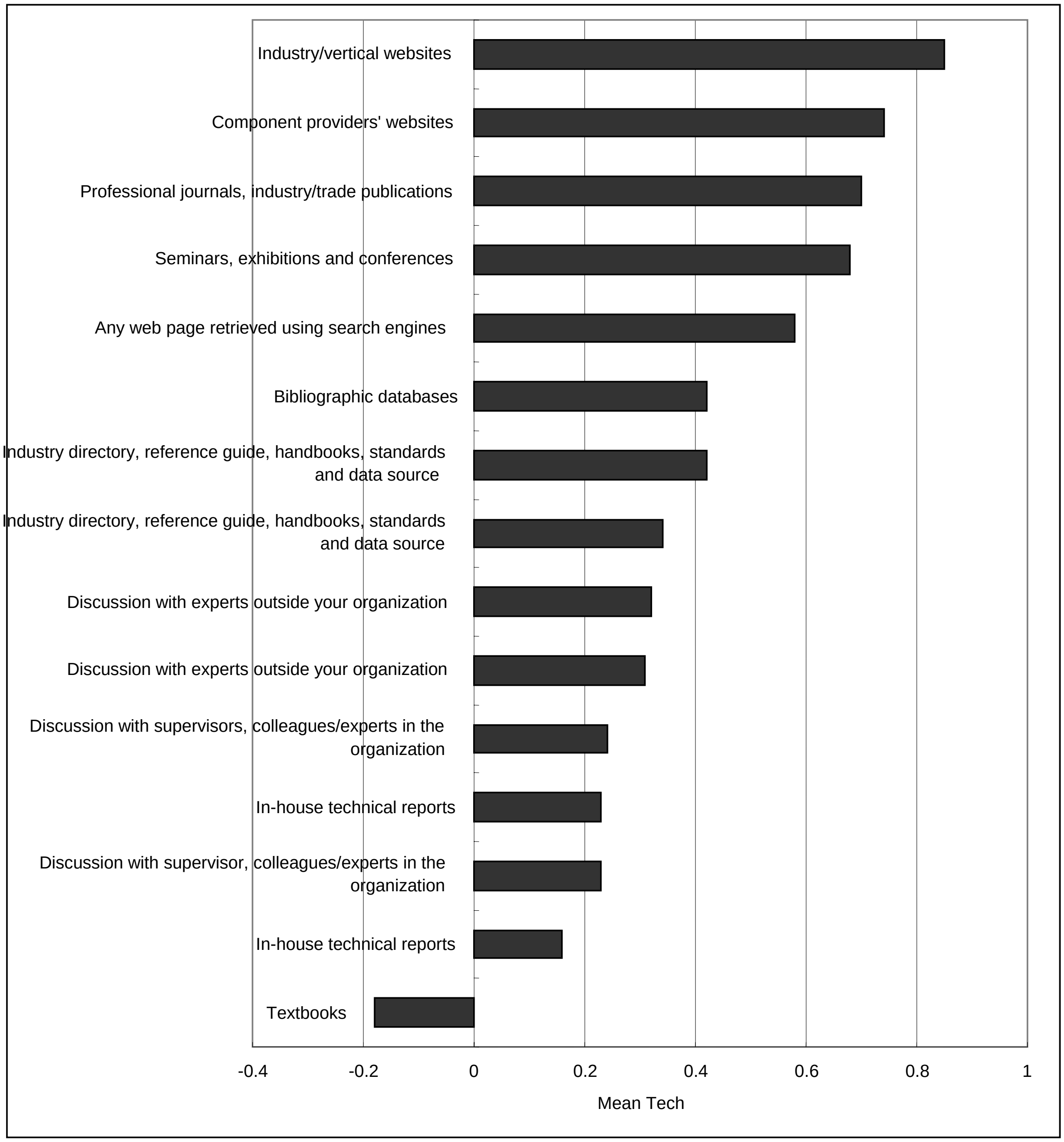

Figure 5. Use pattern for information on latest technological developments

(Note: -2 = strongly disagree, -1 = disagree, 0 = neutral, 1 = agree, 2 = strongly agree)

For new product information, subjects notably prefer industry/vertical websites, component providers' websites, any web page retrieved using search engines, seminars/exhibitions/conferences, and print periodicals. They may also use other information sources except textbooks. Again textbooks get a negative value, showing subjects do not consider textbooks as an information source for product information.

Table 18

Statistics for information source use on new product information

Source	Mean	N	RRE	Std. Dev.
Industry/vertical websites	0.82	339	29%	0.75
Component providers' websites	0.81	864	74%	0.73
Any web page retrieved using search engines	0.67	421	36%	0.86
Seminars, exhibitions and conferences	0.63	324	28%	0.89
Professional journals, industry/trade publications	0.61	284	24%	0.80
Industry directory, reference guide, handbooks, standards and data source	0.48	256	22%	0.95
Bibliographic databases	0.35	275	24%	1.06
Industry directory, reference guide, handbooks, standards and data source	0.32	306	26%	1.00
Discussion with experts outside your organization	0.28	418	36%	1.01
Discussion with experts outside your organization	0.28	272	23%	1.06
Discussion with supervisors, colleagues/experts in the organization	0.23	569	49%	1.06
Discussion with supervisor, colleagues/experts in the organization	0.23	286	25%	1.00
In-house technical reports	0.19	216	19%	1.03
In-house technical reports	0.08	250	21%	1.20
Textbooks	-0.20	320	27%	1.23

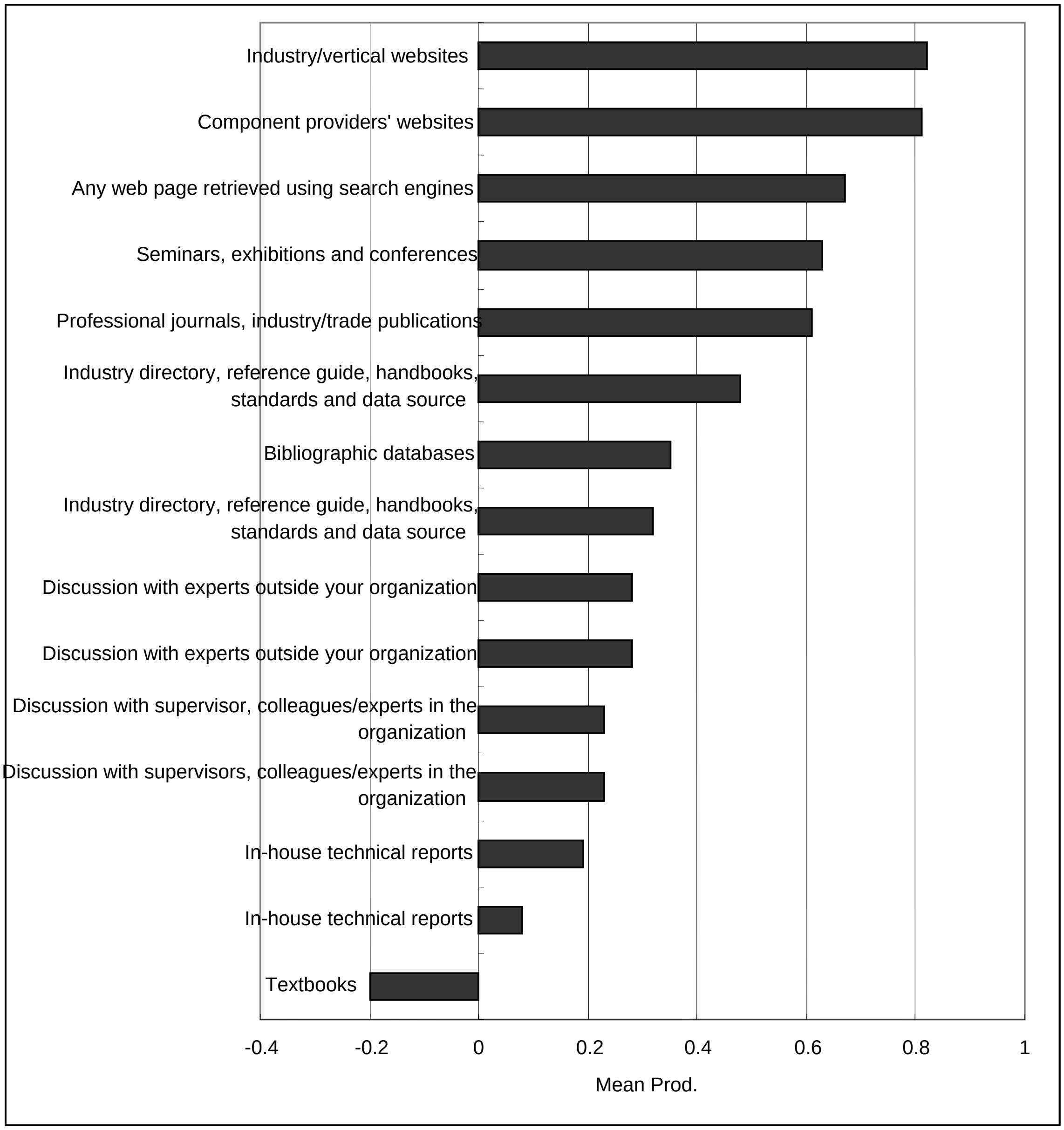

Figure 6. Use pattern for information on new products

(Note: -2 = strongly disagree, -1 = disagree, 0 = neutral, 1 = agree, 2 = strongly agree)

For design information, subjects would use all information sources, though they notably prefer industry/vertical websites, component providers' websites, bibliographic databases, and any web page retrieved using search engines. Discussion with experts outside of the organization ranks lowest on the list.

Table 19

Statistics for information source use for design information

Source	Mean	N	RRE	Std. Dev.
Industry/vertical websites	0.76	337	29%	0.76
Component providers' websites	0.61	864	74%	0.81
Bibliographic databases	0.57	279	24%	0.83
Any web page retrieved using search engines	0.56	423	36%	0.84
Professional journals, industry/trade publications	0.51	284	24%	0.77
Industry directory, reference guide, handbooks, standards and data source	0.51	258	22%	0.97
Discussion with supervisors, colleagues/experts in the organization	0.47	573	49%	0.93
In-house technical reports	0.46	214	18%	0.86
Textbooks	0.45	318	27%	1.00
Discussion with experts outside your organization	0.43	422	36%	0.96
Seminars, exhibitions and conferences	0.43	320	27%	0.96
Industry directory, reference guide, handbooks, standards and data source	0.43	306	26%	0.94
In-house technical reports	0.37	252	22%	1.01
Discussion with supervisor, colleagues/experts in the organization	0.32	288	25%	1.01
Discussion with experts outside your organization	0.26	270	23%	1.08

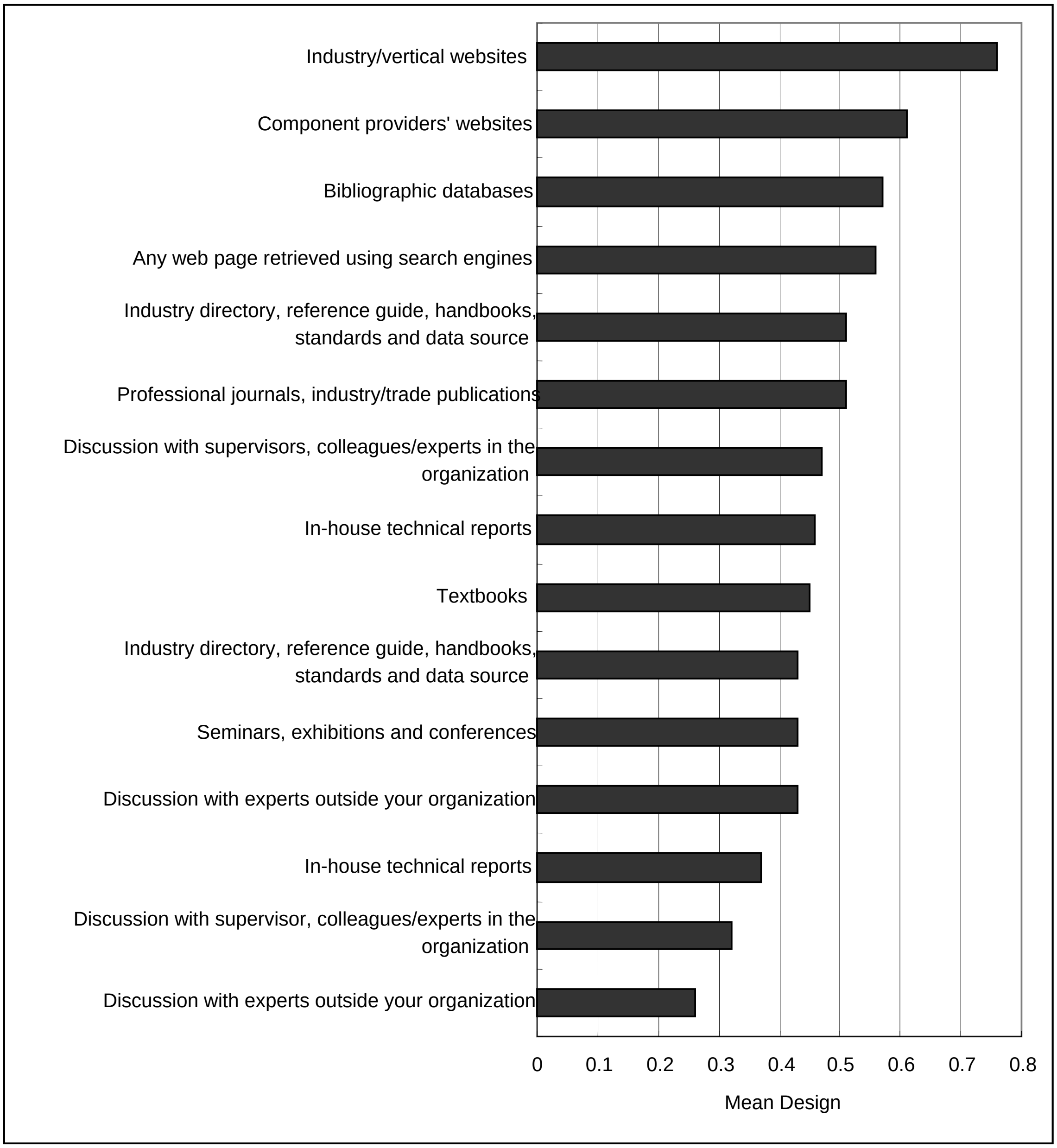

Figure 7. Use pattern for design information

(Note: -2 = strongly disagree, -1 = disagree, 0 = neutral, 1 = agree, 2 = strongly agree)

For application information Subjects would use all information sources, though they prefer industry/vertical websites, component providers' websites, any web page retrieved using search engines, online bibliographic databases and print periodicals. In-house technical reports and discussion with experts outside of the organization rank low on the list.

Table 20

Statistics for information source use on application information

Source	Mean	N	RRE	Std. Dev.
Industry/vertical websites	0.84	340	29%	0.72
Component providers' websites	0.80	871	75%	0.63
Any web page retrieved using search engines	0.73	426	37%	0.80
Bibliographic databases	0.65	281	24%	0.76
Professional journals, industry/trade publications	0.59	282	24%	0.72
Discussion with supervisors, colleagues/experts in the organization	0.55	576	49%	0.85
Seminars, exhibitions and conferences	0.52	322	28%	0.88
Industry directory, reference guide, handbooks, standards and data source	0.49	255	22%	0.95
Discussion with experts outside your organization	0.47	420	36%	0.89
Industry directory, reference guide, handbooks, standards and data source	0.45	302	26%	0.90
Discussion with supervisor, colleagues/experts in the organization	0.44	291	25%	0.92
In-house technical reports	0.44	217	19%	0.90
Textbooks	0.43	320	27%	0.94
In-house technical reports	0.37	252	22%	0.90
Discussion with experts outside your organization	0.32	271	23%	1.00

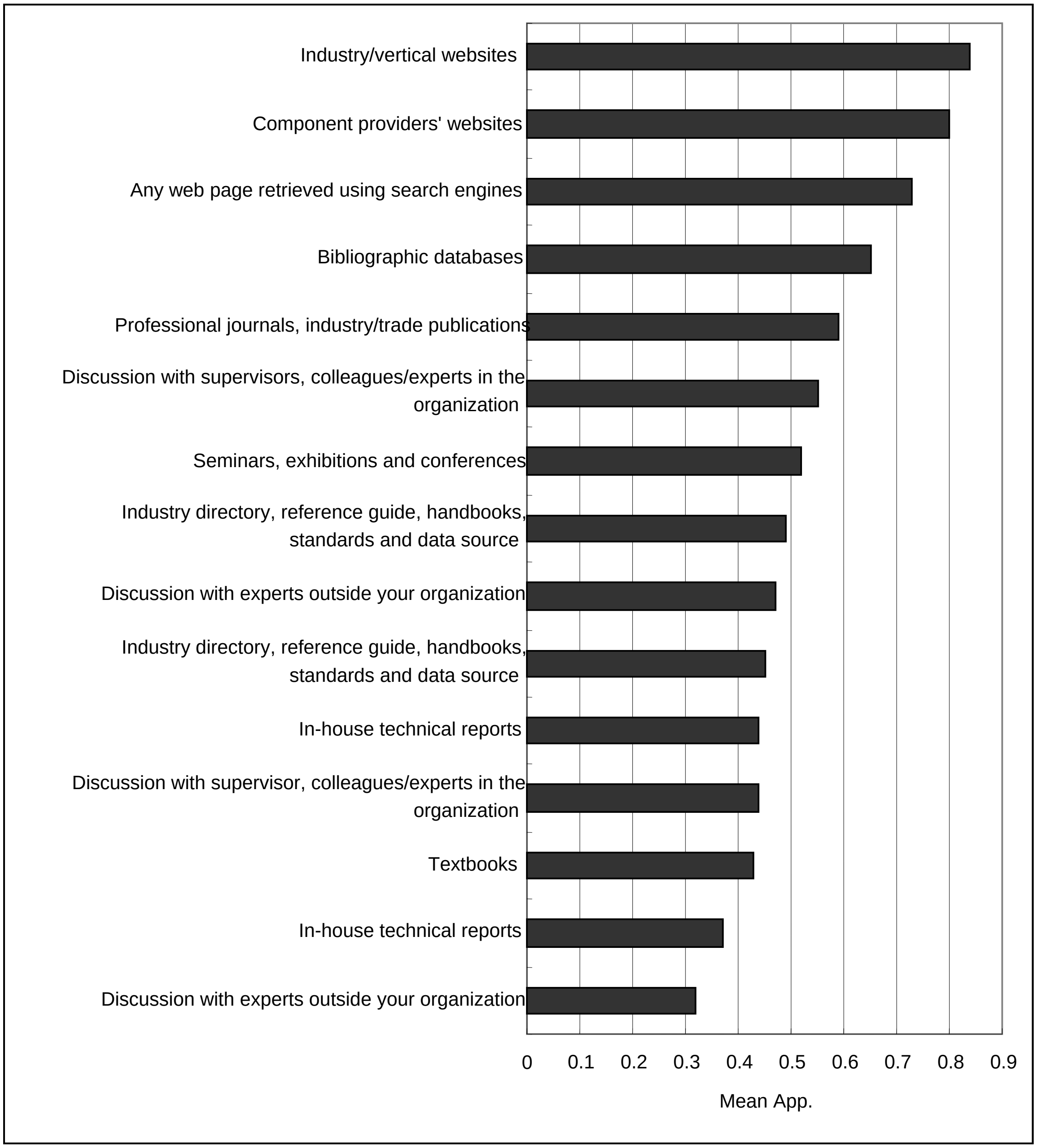

Figure 8. Use pattern for application information

(Note: -2 = strongly disagree, -1 = disagree, 0 = neutral, 1 = agree, 2 = strongly agree)

Subject may encounter useful information when they use all information sources. They are more likely to encounter useful information when they use industry/vertical websites, any web page retrieved using search engines, and component providers' websites, in particular. In-house technical reports, discussion with experts outside of the organization, textbooks, and in-house technical reports rank low on the list.

Table 21

Statistics for information source use on information encountering

Source	Mean	N	RRE	Std. Dev.
Industry/vertical websites	0.87	338	29%	0.75
Any web page retrieved using search engines	0.76	425	37%	0.81
Component providers' websites	0.69	861	74%	0.72
Professional journals, industry/trade publications	0.64	285	24%	0.76
Discussion with supervisors, colleagues/experts in the organization	0.60	573	49%	0.85
Industry directory, reference guide, handbooks, standards and data source	0.60	256	22%	0.89
Seminars, exhibitions and conferences	0.58	321	28%	0.87
Bibliographic databases	0.57	276	24%	0.89
Industry directory, reference guide, handbooks, standards and data source	0.49	301	26%	0.91
Discussion with supervisor, colleagues/experts in the organization	0.45	286	25%	0.94
Discussion with experts outside your organization	0.45	267	23%	0.91
In-house technical reports	0.38	251	22%	1.02
Discussion with experts outside your organization	0.35	417	36%	0.98
Textbooks	0.35	319	27%	1.00
In-house technical reports	0.35	214	18%	1.00

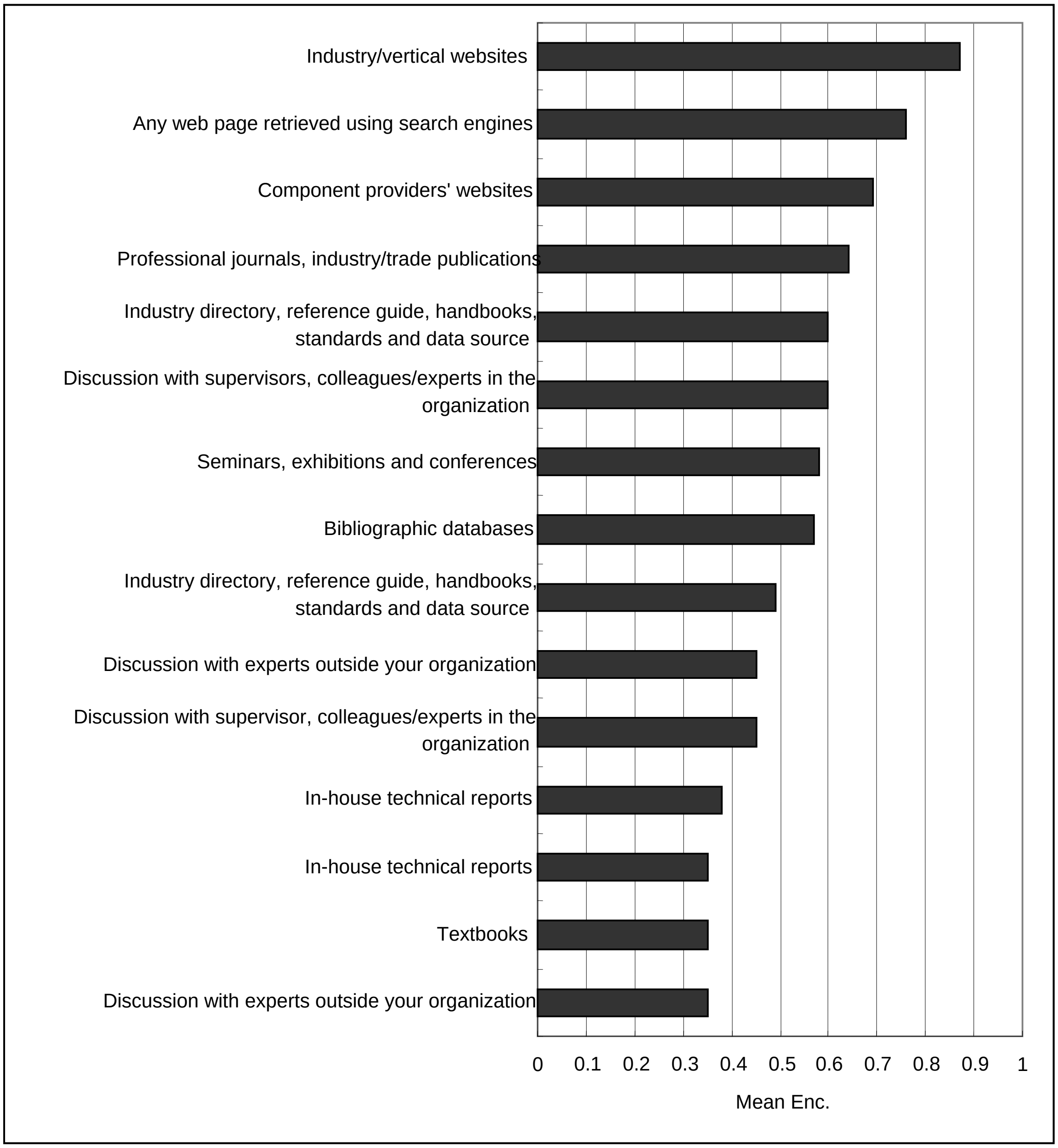

Figure 9. Information encountering using various sources

(Note: -2 = strongly disagree, -1 = disagree, 0 = neutral, 1 = agree, 2 = strongly agree)

4.4 Results for Research Question 2

The second research question tries to uncover how the 12 potential elements examined in this study correlate with the use frequency of information sources, and tries to simplify the structure of these elements. It consists of two sub-questions: 2a, for each information source, which factors correlate significantly with the source's use frequency; and 2b, for all information sources, which factors correlate significantly with overall use frequency.

4.4.1 Sub-question 2a

To answer sub-question 2a, for each information source, Pearson's Correlation between the source use frequency and each potential influencing element is calculated. The correlation coefficients are listed in tables in Appendix A.

Although some participants dropped out of the survey while they proceed, the sample sizes are still sufficient for the analysis conducted. The information source achieving most responses (882) is component providers' websites, and the one achieving the least responses (222) is in-house technical reports. Table 14 lists the number of valid responses for detailed questions on each information source. Correlations between source use frequency and all the potential influencing elements are found to be significant.

For each information source except component providers' website, some moderate correlations ($0.5 > | r | < 0.8$) between use frequency and potential elements were found. Correlation tables are shown in Appendix A. No strong correlation ($| r | \geqslant 0.8$) was found. The first three elements (i.e., "getting to the information source is very easy; it is very reliably available," "getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize," and "I know this information source; it worked for me in the past") demonstrate moderate correlations with the use of most information sources. Other four elements each moderately correlate with one information source. No element correlates moderately with the use of source "component providers' websites." Table 22 and 23 list all the correlations greater than .45 between source use and the potential influencing elements.

Table 22

Three elements show moderate correlations with use frequency of most sources

	Easy to reach, reliably available	Info easy to retrieve, understand, utilize	Familiarity/past experience
Provider sites			
F2f int. dis.	.571(**)	.502(**)	.465(**)
Email ext. dis.	.500(**)	.458(**)	
Search engines	.506(**)	.493(**)	
Online Int. dis.	.619(**)	.607(**)	.559(**)
Online ext. dis.	.537(**)	.499(**)	.520(**)
F2f events	.549(**)	.481(**)	
Vertical sites	.542(**)	.531(**)	.546(**)
Print Ref. tools	.579(**)	.548(**)	.524(**)
Textbooks	.537(**)	.480(**)	
Print int. reports	.499(**)		.473(**)
Print periodicals	.583(**)	.482(**)	.455(**)
Online Ref. tools	.645(**)	.586(**)	.574(**)
Online int. reports	.582(**)	.511(**)	.497(**)
Online databases	.659(**)	.625(**)	.565(**)

** Correlation is significant at the 0.01 level (2-tailed).

Table 23

Five elements show moderate correlations with use frequency of one or two sources

	Authority	Coverage	Detailed, complete info	Relevance	Distance
Online ext. dis.					.458(**)
Print Ref. tools	.503(**)		.488(**)	.459(**)	
Online Ref. tools				.500(**)	.576(**)
Online databases		.461(**)			

** Correlation is significant at the 0.01 level (2-tailed).

4.4.2 Sub-question 2b

Sub-question 2b does not treat each information source separately. It endeavors to uncover which factors affect the use of information sources in general. To answer sub-question 2b, all datasets were collapsed regardless of information sources. The correlation coefficients between use frequency and potential influencing elements were calculated and listed in Table 24. Only three elements (i.e., “getting to the information source is very easy; it is very reliably available,” “getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize,” and “I know this information source; it worked for me in the past”) show moderate correlations with overall source use. Squared correlation coefficients of another five elements are greater than 0.1. Squared correlation coefficients of the rest variables with source use are less than 0.1.

Table 24

Correlations between potential influencing elements and the use frequency of information sources in general

	Pearson's Correlation	R square	N
Easy to reach, reliably available	.564(**)	.318	5456
Info easy to retrieve, understand, utilize	.513(**)	.263	5433
Familiarity/past experience	.504(**)	.254	5419
Distance	.418(**)	.175	5405
Time-saving	.367(**)	.135	5393
Relevance	.340(**)	.116	5402
Authoritativeness	.319(**)	.102	5401
Coverage	.316(**)	.100	5389
Detailed, complete info	.284(**)	.081	5407
Format	.279(**)	.078	5366
Easy to use	.251(**)	.063	5401
Selectivity	.229(**)	.052	5386

** Correlation is significant at the 0.01 level (2-tailed).

Another purpose of sub-question 2b is trying to find out the structure among variables, or to reduce the number of factors through factor analysis. The first step is to extract principal components from the top three variables, which showed moderate correlation with information source use. Table 25 through 27 shows the results of factor analysis. Table 25 shows that the three elements (i.e., information source being easy to reach and reliably available; information from the source being easy to retrieve, understand and utilize; and familiarity/past experience) are moderately correlated with each other. Table 26 shows that only one principal component (component 1) with an eigenvalue greater than 1 is extracted. It accounts for most of the variance of the three variables. Table 27 shows that the above-mentioned three variables contribute almost equally to the extracted principal component.

Table 25

Correlation matrix of top three elements

Correlation	Easy to reach, reliably available	Info easy to retrieve, understand, utilize	Familiarity/past experience
Easy to reach, reliably available	1.000	.690	.578
Info easy to retrieve, understand, utilize	.690	1.000	.644
Familiarity/past experience	.578	.644	1.000

Table 26

Total variance explained by components extracted from top three elements

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var.	Cum.%
1	2.276	75.860	75.860	2.276	75.860	75.860
2	.427	14.230	90.090			
3	.297	9.910	100.000			

Extraction Method: Principal Component Analysis.

Table 27

Component matrix with top three elements

	Component 1
Easy to reach, reliably available	.869
Info easy to retrieve, understand, utilize	.897
Familiarity/past experience	.847

Extraction Method: Principal Component Analysis.

1 component extracted.

The next step is to extract principal components from variables whose squared correlation coefficients with source use are greater than 0.1 (i.e., information source being easy to reach and reliably available; information retrieve from the source being easy to retrieve, understand and utilize; familiarity/past experience; physical distance; time-saving ability;

relevance; authoritativeness; and coverage). By conducting factor analysis using SPSS, one principal component (component 1) with an eigenvalue greater than 1 is extracted. It accounts for more than half of the total variance. Another principal component (component 2) with an eigenvalue close to 1 is also extracted. Table 28 through 30 lists the results of factor analysis.

Table 28

Correlation matrix of eight prominent elements

Correlation	Easy to reach, reliably available	Info easy to retrieve, understand, utilize	Familiarity, past experience	Authority	Coverage	Relevance	Distance	Time-saving
Easy to reach, reliably available	1.000	.691	.580	.398	.396	.404	.492	.411
Info easy to retrieve, understand, utilize	.691	1.000	.648	.427	.403	.413	.491	.425
Familiarity/past experience	.580	.648	1.000	.486	.414	.425	.452	.397
Authority	.398	.427	.486	1.000	.578	.439	.287	.350
Coverage	.396	.403	.414	.578	1.000	.496	.310	.360
Relevance	.404	.413	.425	.439	.496	1.000	.428	.448
Distance	.492	.491	.452	.287	.310	.428	1.000	.453
Time-saving	.411	.425	.397	.350	.360	.448	.453	1.000

Table 29

Total variance explained by extracted components from eight elements

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Var.	Cum. %	Total	% of Var	Cum. %
1	4.143	51.784	51.784	4.143	51.784	51.784
2	.946	11.819	63.603	.946	11.819	63.603
3	.775	9.692	73.296			
4	.540	6.745	80.041			
5	.479	5.988	86.029			
6	.448	5.596	91.624			
7	.376	4.700	96.325			
8	.294	3.675	100.000			

Extraction Method: Principal Component Analysis.

Table 30

Component matrix with eight elements

	Component 1	Component 2
Easy to reach, reliably available	.772	-.317
Info easy to retrieve/understand/utilize	.797	-.301
Familiarity/past experience	.777	-.151
Authoritativeness	.684	.492
Coverage	.680	.539
Relevance	.698	.261
Distance	.676	-.356
Time-saving	.658	-.063

Extraction Method: Principal Component Analysis.

2 components extracted.

It is worth noting that principal component 1 correlates positively with all the above-mentioned eight elements from which it is extracted. However, principal component 2 negatively correlates with five elements, whereas positively correlates with other three elements. The implications of this phenomenon are discussed in Chapter 5.

4.5 Summary

This chapter presented the process and results of analysis on the data collected through the online survey. It described subjects' use patterns of information sources, including use frequencies of each information source, as well as subjects' purposes using each source. The results showed that subjects use all the information sources rather frequently, though they generally prefer online sources. In addition, the researcher identified three elements (i.e., information source being easy to reach and reliably available; information from the source being easy to retrieve, understand and utilize; and familiarity/past experience) moderately correlated with information source use, but no element strongly correlated with source use. Factor analysis using the above-mentioned three elements yielded one strong principal component which accounts for nearly 76% of total variance. Factor analysis using more elements yielded another weak principal component with an eigenvalue close to 1.

CHAPTER 5: DISCUSSION

5.1 Overview

In this chapter, findings from the quantitative analysis in Chapter 4 are interpreted to answer the research questions first brought up in Chapter 1. Discussions and implications are made regarding Chinese electronics engineers' use patterns of various information sources, the primary purposes using each source, and factors influencing the use of the information sources.

Limitations affecting the results of the study are clarified. The limitations primarily centers on sampling bias and the effectiveness of the data collection instrument. Recommendations for future studies and are also proposed in this chapter.

5.2 Patterns of Information Source Use

The first research question aims to describe the patterns of Chinese electronics engineers' work-related information source use. It consists of sub-question 1a (at what frequencies do Chinese electronics engineers use various information sources for their work) and sub-question1b (for what specific purposes do Chinese electronics engineers use each information source).

For information source use patterns, the findings suggest that Chinese electronics engineers have access to a variety of information sources of different kinds, and they use all of them rather intensively to acquire information. No single information source or a single format of information source can take the place of others.

The availability of various Internet-based information sources provides subjects with more options than ever before when they seek information. Compared with relatively recent studies, e.g., Tenopir and King (2004) and Yitzhaki and Hammershlag (2004), the use of Internet-based sources in this study use is much heavier. Among the top three most popular sources in the study of Yitzhaki and Hammershlag, none is Internet-based. In contrast, all the top three sources in this study are Internet-based. This phenomenon is the reflection of the fast adoption of information technology in recent years.

The work of Yitzhaki and Hammershlag also suggests that discussions, or inter-personal communication, are a preferable information sources for Israeli engineers. In contrast, this study shows that Chinese subjects favor unidirectional sources such as web pages and print media. This finding is consistent with the results of a survey conducted among 21IC.com users which showed that subjects considered themselves more introverted compared to their non-engineering colleagues (McClenahan Bruer Communications, 2007). When inter-personal communication is needed, e.g., subjects in this study prefer face-to-face discussion over discussion via email or online forums and chats, showing the same behavior of Israeli engineers.

Not surprisingly, almost a synonym of the Internet, search engines rank on top of all other information sources. Search engines are used by Chinese electronics engineers for all work-related purposes: finding information on latest technical development, product information, design information, and application information.

The most notable information source, perhaps, is industry or vertical websites. Although the samples were drawn from magazine subscribers, the use of industry or vertical websites still ranks high - only second to that of search engines. It seems that vertical websites are taking the place of industry magazines of the pre-Internet age. Vertical websites are the subjects' first choice when they perform the four work-related information-seeking activities – for information on latest technological development, for product information, for design information, and for application information. Search engines, the number one frequently used information source, rank second in this aspect. This further confirms the position of vertical websites as an important source for high-quality information.

For information encountering, subjects reported that they may encounter useful information when using all information sources. In particular, they are more likely to encounter useful information when they use industry/vertical websites, search engines, and component providers' websites in particular. This may imply that online information sources facilitate Chinese engineers' information encountering. This is consistent with Erdelez (2005)'s notion that the characteristics of the information environment (e.g., print, face-to-face, Web) are factors that affect the level of information encountering.

Unlike traditional print information sources, the information structure of the Web is inherently non-linear. A webpage often holds a number of relevant links. This is often intentionally designed to order to increase page views per visit, a benchmark commonly used to measuring the performance of a Web site. For example, keywords or terminologies in an online article are usually hyperlinked to a list of other articles related to them. Tags are widely used, maximizing interlinks between web pages. This non-linear, inter-linked nature of online resources apparently facilitates information encountering than traditional sources.

5.3 Factors Influencing Source Use

Research question 2 tries to identify factors affecting the use of these information sources. Sub-question 2a examines each information source individually. For each information source, Pearson Correlation coefficients between potential influencing elements and the information source's use frequency were calculated. The following findings are worth of discussion regarding research question 2a.

No element is found to be strongly correlated ($|r| \geqslant 0.8$) with the use of an information source. Because all the elements are found to be related with information source use in previous studies, this finding is somewhat beyond the researcher's expectation. If this finding is true, it can be concluded that no single element listed dominate a subject's use of an information source. In other words, subjects' use of an information source often depends on multiple considerations.

Another explanation is that the researcher's instrument was not sensitive enough to detect strong correlations if they do exist. One possible reason is that Chinese subjects tend to be too polite to say "no" even when they are encouraged to do so. As a result, all the data would cluster around the mean, decreasing the resolution of the measuring instrument. To find out the real answer to this question, other research designs are recommended to remedy potential precision problems of this study. For example, on-site structured interviews might help to identify subjects' real reaction to each question item.

A number of reasons are found to be moderately correlated ($0.5 > | r | < 0.8$) with the use of all the information sources except the source component providers' websites. They are "getting to the information source is very easy. It is very reliably available," "getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize," and "I know this information source; it worked for me in the past." Ease, or effortlessness, is the common trait of the three elements. They respectively define the ease of accessing to an information source, the ease of navigating with in the information source, the ease of retrieving information from an information source, and the ease of digesting information retrieved from an information source.

In contrast, most scholars' concept of accessibility, the one often considered the primary factor associated with the use of information sources, does not appear obviously associated with source use. Pinelli, Bishop, Barclay, and Kennedy (1993) interpreted accessibility as the physical distance between the subjects and the information source.

However, physical distance only showed weak correlation with information source use in this study. Even most of the accessibility elements identified by Fidel and Green (2004), such as document format, level of detail, and amount of information in one place, were not found to be strong influencing factors.

No element is found to be moderately correlated with the use of the source component providers' websites. This may imply that subjects simply have to use this information source just because they use the providers' components – they need to visit the providers' sites to retrieve information necessary for their design work such as part parameters, application notes, and white papers. Other factors have little impact under this context.

Research question 2b deals with all information sources in general. All the elements examined are found to be significantly related to the use of information sources. Among them, three elements (i.e., "getting to the information source is very easy; it is very reliably available," "getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize," and "I know this information source; it worked for me in the past.") show moderate correlations with overall source use, whereas others only demonstrate weak correlations with source use. This finding is in consistency with the findings reported for research question 2a.

Correlation matrix among the three elements moderately correlated with source use shows that they also moderately correlate with each other. This demonstrates that although the three elements measure certain elements in common, they are by no means identical. In other words, each element also measures something unique that neither of the other two does. None of the elements can be fully represented by the other two.

Factor analysis generated one principal component with an eigenvalue greater than 1. It accounts for nearly 76% of the total variance, with each variable contributing almost equally to the component. Apparently the three variables measure one important factor together from different angles. The researcher named the component EASE - the ease of accessing to an information source, the ease navigating within the information source, the ease retrieving information from an information source, and the ease digesting information retrieved from an information source.

When adding additional elements to the list for principal component analysis, a weak component with an eigenvalue close to 1 was found. This component correlates negatively with five elements emphasizing ease of acquiring information, but positively with other three elements concentrating on quality. The second component can be defined as QUALITY BUT EASE. It depicts the quality of information being pursued with no regard to effort needed to acquire the information. Because its eigenvalue is only close to 1, the effect of this factor upon subjects' selection of information sources is barely detectable.

The structure of the principal components in this study is similar to that of Hardy's 1982 study of the U.S. Forest Services professionals, which identified SPEED and CONTENT as strong and weak factors respectively. Hardy's SPEED contains ease of use, time-saving ability, and promptness. In this study, however, time-saving ability and promptness were not found to be major affecting factors. This may imply the information behavior difference between the U.S. Forest Services professionals and Chinese electronics engineers.

The biggest difference between the findings of this study and previous ones, however, is that no dominant factor is identified. This is in sharp contrast with the claim by many scholars that accessibility is THE factor, or Hardy's conclusion that SPEED is a strong factor determining subjects' selection of information sources. In this study, EASE is the most prominent principal component, but it is derived from elements which at most moderately correlate with information source use.

5.4 Possible Role of the Engineering Culture

Respondents' information source use pattern revealed in this study might also be connected to the engineering culture. According to the definition in the Merriam Webster dictionary, an engineer is a person who is trained in or follows as a profession a branch of engineering, the application of science and mathematics by which the properties of matter and the sources of energy in nature are made useful to people. Engineers share some commonalities such as education background, working environment, and job requirements. They form a distinct occupational community which cuts across nations and industries, sharing a sub-culture which can be labeled the "engineering culture" (Kunda, 1992).

Impersonality is a noticeable aspect of the engineering profession (Harrison et al, 2006). Engineers often recognize human factors in the process of their design work, but incline to design humans out of their final products. In the same token, engineers are confident and willing to deal with systems. This sub-culture of the engineering community may help to explain the phenomenon that subjects use non-human information sources more frequently than interpersonal communication.

5.5 The Findings and Zipf's Principle of Least Effort

The findings of this research are consistent with Zipf's general concept of Principle of Least Effort, which asserts that a person will strive to minimize his or her effort when solving problems. In the field of human information behavior, the Principle of Least Effort should be interpreted as such: a person will strive to solve his or her problems in such a way as to minimize the total work of information seeking in solving both his immediate problems and his or her probable future problems (as estimated by himself). Often solving the immediate problems is of higher priority than future problems, so an information seeker would select the information sources with the property of the greatest ease. However, by doing so the information seeker may not feel comfortable when considering probable future problems – using a low-quality information source may result in more work in the future. So he or she may also have quality considerations when choosing information sources. But because future problems are only probable, quality is often a secondary consideration. Reflected in the findings of this research, EASE is found to be a prominent factor associated with source use frequency, whereas the effect of QUALITY is merely detectable.

A number of scholars in the field of library and information science stated that their findings were supportive of Zipf's Law. They reported that subjects' information-seeking behavior was found to be closely related with factors such as ease of use (Rosenberg, 1966; Salasin & Cedar, 1985), accessibility (Allen & Gerstberger, 1967; Harris, 1966; Allen, 1977), and preference of interpersonal sources (Chen & Hernon, 1982; Dervin, 1983). Most previous studies did not fully examine Zipf's definition of Principle of Least Effort; they ignored Zipf's concept of average work expenditure. However, these studies show that information seekers prioritized immediate problems – they had little consideration for information quality, the factor that would possibly affect their future problems.

Because this research was not designed to test rigorously Zipf's Law, the distribution of source use frequencies measured in this study does not strictly follow Zipf's curve. For example, the measured mean value of the frequency variable of the top most frequently used source is not exactly twice that of the second most frequently used source. This does not mean that subjects' actual use of information sources does not follow Zipf's curve. If testing Zipf's curve was the main purpose of a study, a researcher may employ field observation to precisely record subject's daily use of specific information sources, instead of using survey method self-reporting.

Information encountering occurs when one is looking for information relating to one topic and finds information relating to another one (Erdelez, 1999). Information encountering is related to Zipf's Law in that it may help to solve the information seeker's future problems rather than immediate problems. Because the encountered information is not related to the person's topic in mind, it will not be helpful to solve his immediate problems. However, if he memorizes it, includes it in his personal collection, or remembers its location for later use, he may reduce his effort in the future, thus minimize the probable average rate of his work-expenditure over time.

5.6 The Role of Technological Leapfrogging

It is natural to associate Chinese electronics engineers' intensive use of Internet information sources to China's technological leapfrogging. "Leapfrogging" is the notion that developing countries can bypass the intermediary steps experienced by developed countries and move directly to the adoption of modern technology. China's adoption of mobile phones is an example of leapfrogging. Before China's economic reform starting in the late 1970s, the telephone was a luxury for most China's citizens. With the rapid deployment of modern telecommunication infrastructure in recent years, the telephone has become common merchandise in China. Although installment of fixed phones has been growing during the years, the market for mobile phones grew faster. According to China's Ministry of Industry and Information Technology, the number of mobile phone users reached 601 million by the end of June 2008. In contrast, the number of fixed phone users was 356 million (Ministry of Industry and Information Technology of the People's Republic of China, 2008).

A competitor of traditional print media, the Internet has been expending dramatically during the past ten years. According to the China Internet Network Information Center, China has surpassed the United States to become the country with the largest number of Internet users. By the end of June 2008, China had 253 million Internet users, including 214 million broadband users (Ministry of Industry and Information Technology of the People's Republic of China, 2008). For Chinese knowledge workers such as electronics engineers, using the Internet has become part of their daily life.

However, the phenomena that respondents use electronic information sources more frequently than print sources cannot be attributed fully to the technological leapfrogging. Unlike the situation of fixed phone against mobile phone, distribution of technical print information sources among Chinese electronics engineers was prevalent before the Internet became the prime media. For example, in the beginning of 2000 there were five major technical magazines in mainland China for electronics engineers. The total circulation of these magazines was around 150,000, reaching most of China's electronics engineers. More importantly, all of the respondents in this study were magazine subscribers, so access to print media was not a problem. In conclusion, technological leapfrogging cannot explain respondents' heavier use of electronic media.

The rapid transition from traditional sources to electronic sources might be better explained by the slack enforcement of intellectual property protection than technological leapfrogging. The popularity of vertical websites is a typical case. Although China's intellectual protection regulations stipulates that publishing unauthorized contents is illegal, in reality vertical websites often copy others' copyrighted contents free of punishment. As a result, vertical websites provide much more content than any print periodical has to offer. For electronics engineers, vertical websites are one-stop centers for all categories of information.

Another possible reason for the heavy use of electronic sources is that Chinese electronics engineers are very young. Many of them are new graduates from universities. Young people tend to adopt new technologies faster; they are mostly intensive Internet users. In addition, students are often not eligible for magazine subscription so they would use more Internet sources than print ones. When they graduate, they would keep their information-seeking behavior, resulting in more electronic source use than print ones.

5.7 Limitations of the Study

This study described the patterns of information source use by Chinese electronics engineers, and identified factors that affect their selection of information sources. Though the study generates some important findings, it has a number of limitations.

The primary limitation of the study is a result of the sampling method. The sample was drawn from a particular group of engineers – those who opted to subscribe to the magazine *Electronic Products China.* The findings of the study cannot be generalized to the whole population of Chinese engineers without conducting more studies with different samples. This study can serve as a starting point when conducting similar studies using other groups of Chinese electronics engineers.

Lack of complete and accurate demographic data of the respondents limits the extrapolation of the findings of this study to other subject groups. This research did not collect complete respondent demographic data. Demographic data help to describe population characteristics and demographic profiles.

Commonly used demographics include race, age, gender, income, marital status, education, geographic location, and occupation.The researcher asked only one demographic question in the questionnaire: the respondent's age. The researcher considered asking more demographic questions such as gender, the size of companies they work for, their work function, and educational background. These questionnaire items were not added to the questionnaire as a result of two considerations. One consideration was that inclusion of more questionnaire items would make the questionnaire longer, and a long questionnaire may potentially lower the response rate.

The magazine's database provides some additional demographic data of all the subscribers. Although respondent demographics could at some degree differ from those of all magazine subscribers, a description of the subscriber data would be substitute in understanding the subject group's demographic characteristics.

Electronic Products China magazine's circulation proprietary database shows that the subscribers are mostly male. The majority of respondents are male, accounting for 93 percent of the total. Most of the subscribers work for smaller companies, with more than

42 percent subscribers working in companies with less than 100 employees, and another 28 percent in companies with 100 to 499 employees. In terms of geographical location, the subscribers are mostly distributed along China's coastline. Over 22 percent of the subscribers are located in Guangdong province in South China around Shenzhen, another 28 percent are located in East China around Shanghai, and another 14 percent are located in North China around Beijing. Fewer than 35 percent of the magazines total subscribers are located in inland China.

The design of this research could be improved by collecting a number of additional demographics. Besides age, respondents' income, marital status, education level, geographic location, years of employment, and work function may also have impact on their information behavior. These questions should be asked at the beginning of the questionnaire, and they would not take respondents too much time to answer. These demographics could not only give a complete and accurate description of the subject group, but also provide opportunities for more in-depth data analysis. For example, the respondents could be divided into groups of different education levels, and their information use of a particular information source could be compared: respondents with higher education levels might use information sources of higher quality more frequently than those with lower education levels.

Another limitation of this research is associated with the online survey research method. The reliability of remotely self-reported data is difficult to control, especially when incentives are provided. Subjects might be too casual to answer questions seriously, or too polite to give negative answers. This situation may lower the resolution of the measuring instrument, or even generates false data that misleads results. Fortunately the sample size of this study is large enough to allow for stringent data cleaning, minimizing the chance of generating wrong results.

5.8 Recommendations for Future Studies

Based on the above discussions, a number of recommendations are proposed for future studies. Using the collected data, additional data analysis could be conducted to generate more findings. In order to expand the validity of this study's results to broader category of Chinese electronics engineers, it is recommended that further studies use different subject groups. Other research methods, e.g., structured interviews, are also recommended for in-depth investigation.

A number of additional data analyses can be conducted using data collected in this study. Respondents in this study can be divided into groups to comparison studies. For example, respondents can be divided into two age groups: the younger engineers and older engineers. Comparison analysis can be conducted to test hypothesis that the two groups of engineers have different patterns of information source use. The following hypotheses can be tested:

- Younger engineers use vertical sites more frequently than older engineers
- Younger engineers use online forums/chats more frequently than older engineers
- Older engineers use print periodicals more frequently than younger engineers

- Information source quality correlates with source use more strongly for older engineers than for younger engineers
- Younger engineers are more likely to be information encounters than older engineers

The previous section on limitations discussed the addition of more respondent demographic questions, such as respondents' income, marital status, education level, geographic location, years of employment, and work function. When more demographic data are collected, additional meaningful comparisons can be made. For example, the following hypotheses can be tested regarding years of work experience and education level:

- Engineers with more years of work experience use online forums/chats more frequently than those with fewer years of work experience (because senior engineers do not need as much help for their work as junior engineers do)
- Information source quality correlates with source use more strongly for engineers with more years of work experience than for those with fewer years of work experience
- Information source quality correlates with source use more strongly for engineers with higher education level than for those with lower education level

The open-ended, qualitative interview method could be a powerful means to gain in-depth knowledge for follow-up studies. Interviews are often used after results of standardized measures are analyzed in order to gain insight into interesting or unexpected findings. The interview method has a number of advantages. Interviews provide high credibility and face validity in that actual words of participants often convey their powerful emotions. Interviews allow participants to describe what is meaningful or important them using their own words rather than being restricted to predetermined categories. Participants may also feel more relaxed and candid in interviews. Interviews allows the investigator to probe for more details and ensure that participants are understanding questions the way they were intended, and interviewers have the flexibility to use their knowledge, expertise, and interpersonal skills to explore interesting or unexpected ideas or themes raised by participants.

As follow-up study, interviews can be designed to explore some interesting findings. For example, vertical websites are found to be an important information source for Chinese electronics engineers, and they seem to be taking the place of traditional print periodicals. A number of active participants can be approached for interviews for their opinion on print periodicals and vertical websites. For the intensive users of vertical websites, the researcher would like to know how frequently they used to use print periodicals, or whether their use of print periodicals is declining, and, if this is true, what made them transfer from print periodicals to vertical websites. For the heavy users of print periodicals, the researcher would like to know whether their use of online sources has increased during the years, and, if not, what impeded them from turning to online sources.

Besides follow-up interviews for in-depth investigation, studies using other subject groups are recommended to validate the findings of this study. For example, a similar study can be conducted among 21IC users to give light on the information behavior of typical vertical website users. A comparison between the findings of a study among a print periodical and one among a vertical website would be enlightening.

5.9 Summary

This chapter discussed the results of data analysis in Chapter 4. It is concluded that subjects intensively use a variety of information sources to serve their different information needs. Internet-based sources rank high in their use frequency list, and vertical site in the electronics industry are taking the place of periodicals in the pre-Internet age.

Zipf's *Principle of Least Effort* proves to be effective for this subject group. Factor EASE is found to be the only evident factor that affects subjects' use of information sources. Subjects may sometimes use certain information sources for quality reasons, but the impact of factor QUALITY on subjects' selection of information sources is merely detectable.

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Appendix A: SPSS Output Tables

Table A.1 potential element id lookup

id	Description
f1	Getting to the information source is very easy. It is very reliably available.
f2	Getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize.
f3	I know this information source; it worked for me in the past.
f4	Information from this source is authoritative. It is the best in terms of quality, accuracy and reliability.
f5	The information source provides broad coverage of available subject knowledge.
f6	Information retrieved from this source is complete with adequate detail.
f7	This information source provides lots of useful information that often meets the needs of the project. I often use a high percentage of the information retrieved from this source. It is most likely to have the information I need.
f8	The distance to the information source is close.
f9	The information source does not require much skill to use.
f10	Using the information source can save my time. It delivers needed information quickly. Tracking down information using this source takes little time.
f11	The information source can precisely weed out other information and gives me exactly the information I want.
f12	The information source provides me with information/data with the right format.

Table A.2 Correlations between use frequency and potential elements for source 1

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.313(**)	.260(**)	.321(**)	.222(**)	.254(**)	.212(**)	.209(**)	.220(**)	.109(**)	.246(**)	.202(**)	.213(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000
	N	882	879	872	871	865	859	873	869	863	873	861	850	857

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a source_id = 1

Table A.2 Correlations between use frequency and potential elements for source 2

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.571(**)	.502(**)	.465(**)	.261(**)	.155(**)	.180(**)	.261(**)	.420(**)	.214(**)	.328(**)	.243(**)	.264(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	583	577	573	573	570	568	569	571	572	569	574	576	567

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a source_id = 2

Table A.4 Correlations between use frequency and potential elements for source 3

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.500(**)	.458(**)	.477(**)	.394(**)	.272(**)	.259(**)	.306(**)	.326(**)	.151(**)	.299(**)	.235(**)	.249(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.002	.000	.000	.000
	N	433	428	429	424	421	420	425	420	423	424	421	420	418

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 3

Table A.5 Correlations between use frequency and potential elements for source 4

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.506(**)	.493(**)	.477(**)	.103(*)	.228(**)	.209(**)	.281(**)	.322(**)	.235(**)	.243(**)	.117(*)	.211(**)
	Sig. (2-tailed)		.000	.000	.000	.035	.000	.000	.000	.000	.000	.000	.016	.000
	N	429	422	424	423	423	425	426	426	424	423	421	425	419

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a source_id = 4

Table A.6 Correlations between use frequency and potential elements for source 5

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.619(**)	.607(**)	.559(**)	.400(**)	.385(**)	.405(**)	.483(**)	.447(**)	.343(**)	.429(**)	.287(**)	.298(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	296	294	292	291	287	287	289	290	290	284	288	283	286

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 5

Table A.7 Correlations between use frequency and potential elements for source 6

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.537(**)	.499(**)	.520(**)	.287(**)	.359(**)	.302(**)	.368(**)	.458(**)	.324(**)	.421(**)	.241(**)	.233(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	276	272	273	275	271	268	273	270	270	270	273	266	268

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 6

Table A.8 Correlations between use frequency and potential elements for source 7

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.549(**)	.481(**)	.443(**)	.365(**)	.340(**)	.349(**)	.325(**)	.418(**)	.237(**)	.370(**)	.280(**)	.333(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	328	326	324	323	319	324	323	323	320	321	321	324	319

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 7

Table A.9 Correlations between use frequency and potential elements for source 8

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.542(**)	.531(**)	.546(**)	.386(**)	.322(**)	.279(**)	.413(**)	.313(**)	.186(**)	.338(**)	.278(**)	.296(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.001	.000	.000	.000
	N	342	338	334	336	337	339	336	334	334	332	337	335	336

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 8

Table A.10 Correlations between use frequency and potential elements for source 9

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.579(**)	.548(**)	.524(**)	.503(**)	.427(**)	.488(**)	.459(**)	.366(**)	.260(**)	.391(**)	.361(**)	.373(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	313	308	306	308	307	309	306	308	307	306	306	303	304

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 9

Table A.11 Correlations between use frequency and potential elements for source 10

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.537(**)	.480(**)	.444(**)	.343(**)	.272(**)	.268(**)	.266(**)	.396(**)	.230(**)	.294(**)	.276(**)	.257(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	324	322	317	319	319	317	316	317	319	318	322	317	316

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 10

Table A.12 Correlations between use frequency and potential elements for source 11

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.499(**)	.426(**)	.473(**)	.408(**)	.366(**)	.347(**)	.355(**)	.430(**)	.378(**)	.314(**)	.279(**)	.316(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	257	255	253	253	250	251	251	251	252	253	250	253	251

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 11

Table A.13 Correlations between use frequency and potential elements for source 12

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.583(**)	.482(**)	.455(**)	.365(**)	.374(**)	.301(**)	.255(**)	.366(**)	.220(**)	.250(**)	.178(**)	.233(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.003	.000
	N	287	286	286	285	285	283	279	280	284	280	278	284	283

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 12

Table A.14 Correlations between use frequency and potential elements for source 13

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.645(**)	.586(**)	.574(**)	.417(**)	.417(**)	.334(**)	.500(**)	.576(**)	.346(**)	.483(**)	.390(**)	.395(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	260	256	258	253	255	253	252	255	256	256	256	259	253

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 13

Table A.15 Correlations between use frequency and potential elements for source 14

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.582(**)	.511(**)	.497(**)	.442(**)	.426(**)	.382(**)	.408(**)	.404(**)	.238(**)	.436(**)	.353(**)	.331(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	222	219	218	216	219	218	214	214	214	218	215	215	214

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
a source_id = 14

Table A.16 Correlations between use frequency and potential elements for source 15

		freq	f1	f2	f3	f4	f5	f6	f7	f8	f9	f10	f11	f12
freq	Pearson Correlation	1	.659(**)	.625(**)	.565(**)	.434(**)	.461(**)	.434(**)	.442(**)	.546(**)	.237(**)	.410(**)	.390(**)	.444(**)
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	281	274	274	269	273	268	275	274	277	274	270	276	275

** Correlation is significant at the 0.01 level (2-tailed).
a source_id = 15

Appendix B: Online Survey Invitation Letter

尊敬的阁下：

本人郭庆春，是美国密苏里大学信息科学专业的博士候选人。要正式获得博士学位，我必须完成博士论文。此次调查正是为了完成论文而收集数据。您的参与对于我能否获得博士学位十分关键，我非常渴望能得到您的协助。

此次调查采取完全自愿的形式。您和任何单位的关系不会因为此次活动而受到任何影响。您的参与是匿名的，并且收集到的数据也将严格保密。如果您不想回答某个问题，可以跳过去。您也可以随时停止参与。

完成此问卷大约需要 10 分钟。虽然采取自愿的形式，我还是渴望您拨冗完成此问卷，因为此项研究会帮助学者了解工程师如何获得信息，从而改进信息服务的质量。我非常欣赏您对此次重要调查活动的兴趣，并在此表示感谢。如果您对此项研究有任何顾虑或建议，请通过 guo@21ic.com 或 chuck@epc.com.cn 邮箱与我联系。

完成此问卷，您就有机会获得带有“21IC 中国电子网”标志的精美多功能读卡器一个。请留下您常用的 email 地址，以便在您获奖的情况下通知您。

进入调查: http://www.epc.com.cn/inquire/2008/3-27/page1.asp

密苏里大学信息科学专业 博士候选人
《今日电子》杂志/21IC 中国电子网 总编辑
郭庆春

Appendix C: Translation to the Online Survey Invitation Letter

Dear engineers:

My name is Qingchun Guo, a PhD candidate in information science at the University of Missouri, United States of America. To achieve my doctoral degree, I need to finish my dissertation. This survey is a crucial part of my dissertation effort. Your participation in this survey is very important. Your cooperation will be much appreciated.

Your participation is completely voluntary, there are no penalties for not participating, and all the information collected will be kept private and confidential. If for any reason you would rather not answer a question, just skip it. You may choose not to participate in this study at any time.

Survey completion should take approximately 10 minutes. Though your participation in this study is voluntary, I would greatly appreciate your help, because this is an effort to understand how electronics engineers seek information in order to improve information service quality. I appreciate your interest in this important and useful study, and thank you for your participation in advance. If you have questions or comments concerning this study please feel free to contact me at guo@21ic.com or chuck@epc.com.cn.

By completing this questionnaire, you will have a chance to win a memory card reader. Please fill in your email address if you wish to join the lottery, so that I could contact you once you win the prize.

Click this link to enter the survey: http://www.epc.com.cn/inquire/2008/3-27/page1.asp

Sincerely,
Qingchun Guo
Doctoral Student
School of Information Science and Learning Technologies
University of Missouri

Appendix D: Section 1 of the Original Questionnaire in Chinese

电子工程师信息源使用状况及影响因素调查

感谢您同意参与此次调查。请记住，这是一份纯粹学术性的研究，不牵扯任何公司或其他组织的利益。请尽量如实、准确地回答此问卷，特别不要介意表达您的负面评价。您的答案不会影响您和任何个人或单位的关系。

Question 1 of 16

- 您的 Email 是（获奖通知使用）

- 您的年龄段是（仅选一项）

☐ 25 岁以下 ☐ 26 至 30 岁 ☐ 31 至 35 岁 ☐ 36 至 40 岁 ☐ 41 至 45 岁
☐ 46 至 50 岁 ☐ 51 至 55 岁 ☐ 56 至 60 岁 ☐ 60 岁以上

- 请回答您对下列信息源的使用频率

1. 印刷形式的教材/课本
☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

2. 在线形式的文献数据库
☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

3. 印刷形式的会议论文集
☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

4. 在线形式的会议论文集
☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

5. 通过电子邮件与本单位之外的专家讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

6. 通过在线论坛或聊天工具与本单位之外的专家讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

7. 面对面地与本单位之外的专家讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

8. 通过电子邮件与本单位之内的同事或上级讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

9. 通过在线论坛或聊天工具与本单位之内的同事或上级讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

10. 面对面地与本单位之内的同事或上级讨论

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

11. 印刷形式的厂商黄页、参考指南、使用手册、行业标准与数据

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

12. 在线形式的厂商黄页、参考指南、使用手册、行业标准与数据

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

13. 印刷形式的内部技术报告

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

14. 在线形式的内部技术报告

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

15. 印刷形式的专业、行业刊物

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

16. 在线形式的讲座、展览、会议

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

17. 现场/面对面形式的讲座、展览、会议

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

18. 商业推广/宣传性的印刷品

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

19. 商业推广/宣传性的电子邮件

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

20. 供应商（如生产厂商、分销商）的网站

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

21. 政府发布的在线技术报告

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

22. 电子行业网站或更专业的网站

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

23. 通过搜索引擎搜到的任何页面

☐ 总是使用 ☐ 经常使用 ☐ 偶尔使用 ☐ 很少使用 ☐ 从不使用

下一步 重置

Appendix E: English Translation of Questionnaire Section 1

Note: please be as honest and as accurate as possible. You answer will not affect your relationship with any individual or organization.

Check the most appropriate answer to each statement regarding each information source you use for your work.

My age is
□ 25 and below □ 26-30 □ 31-35 □ 36-40 □ 41-45 □ 46-50 □ 51-55 □ 56-60 □ above 60

At what frequency do you use the following information sources?

1. Text books (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

2. Online bibliographical database
□Routinely/always □Frequently □Occasionally □Rarely □Never

3. Conference proceedings (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

4. Conference proceedings (online)
□Routinely/always □Frequently □Occasionally □Rarely □Never

5. Discuss with experts outside of the organization through email
□Routinely/always □Frequently □Occasionally □Rarely □Never

6. Discuss with experts outside of the organization through online forums and chats
□Routinely/always □Frequently □Occasionally □Rarely □Never

7. Discuss with experts outside of the organization face-to-face
□Routinely/always □Frequently □Occasionally □Rarely □Never

8. Discuss with colleagues and supervisors within the organization through email
□Routinely/always □Frequently □Occasionally □Rarely □Never

9. Discuss with colleagues and supervisors within the organization through online forums and chats
□Routinely/always □Frequently □Occasionally □Rarely □Never

10. Discuss with colleagues and supervisors within the organization face-to-face
□Routinely/always □Frequently □Occasionally □Rarely □Never

11. Industry directory, reference guide, handbooks, standards and data source (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

12. Industry directory, reference guide, handbooks, standards and data source (online)
□Routinely/always □Frequently □Occasionally □Rarely □Never

13. In-house technical reports (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

14. In-house technical reports (online)
□Routinely/always □Frequently □Occasionally □Rarely □Never

15. Professional journals, industry/trade publications (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

16. Seminars, exhibitions and conferences (online)
□Routinely/always □Frequently □Occasionally □Rarely □Never

17. Seminars, exhibitions and conferences (face-to-face)
□Routinely/always □Frequently □Occasionally □Rarely □Never

18. Trade/promotional literature (print)
□Routinely/always □Frequently □Occasionally □Rarely □Never

19. Trade/promotional literature (email)
□Routinely/always □Frequently □Occasionally □Rarely □Never

20. Component providers' websites
□Routinely/always □Frequently □Occasionally □Rarely □Never

21. Government technical reports (online)
□Routinely/always □Frequently □Occasionally □Rarely □Never

22. Industry/vertical websites
□Routinely/always □Frequently □Occasionally □Rarely □Never

23. Any web page retrieved using search engines
□Routinely/always □Frequently □Occasionally □Rarely □Never

Please check the appropriate option regarding the source suppliers' websites

1. The frequency at which I use this information source is
□Routinely/always □Frequently □Occasionally □Rarely □Never

2. Getting to the information source is very easy. It is very reliably available.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

3. Getting information from this source is easy and convenient; information retrieved from this source is easy to understand and utilize.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

4. I know this information source; it worked for me in the past.

□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

5. Information from this source is authoritative. It is the best in terms of quality, accuracy and reliability.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

6. The information source provides broad coverage of available subject knowledge.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

7. Information retrieved from this source is complete with adequate detail.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

8. This information source provides lots of useful information that often meets the needs of the project. I often use a high percentage of the information retrieved from this source. It is most likely to have the information I need.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

9. The distance to the information source is close.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

10. The information source does not require much skill to use.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

11. Using the information source can save my time. It delivers needed information quickly. Tracking down information using this source takes little time.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

12. The information source can precisely weed out other information and gives me exactly the information I want.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

13. The information source provides me with information/data with the right format.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

14. Using this information source, I often accidentally come across useful information.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

15. I use it for information on latest technological developments.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don't know

16. I use it for information on new products.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don’t know

17. I use it for design information.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don’t know

18. I use it for application information.
□ Strongly agree □ Agree □ Neutral □ Disagree □ Strongly disagree □Not applicable/don’t know

Go on to the next page >>

Appendix F: 21IC.com Survey Questionnaire

电子工程师信息源使用情况调查

在工作中，您经常使用下列哪些信息源？（可选多项）

- ☐ 印刷形式的教材/课本
- ☐ 在线形式的文献数据库
- ☐ 印刷形式的会议论文集
- ☐ 在线形式的会议论文集
- ☐ 通过电子邮件与本单位之外的专家讨论
- ☐ 通过在线论坛或聊天工具与本单位之外的专家讨论
- ☐ 面对面地与本单位之外的专家讨论
- ☐ 通过电子邮件与本单位之内的专家讨论
- ☐ 通过在线论坛或聊天工具与本单位之内的专家讨论
- ☐ 面对面地与本单位之内的专家讨论
- ☐ 印刷形式的厂商黄页、参考指南、使用手册、行业标准与数据
- ☐ 在线形式的厂商黄页、参考指南、使用手册、行业标准与数据
- ☐ 印刷形式的内部技术报告
- ☐ 在线形式的内部技术报告
- ☐ 印刷形式的专业期刊、行业/商业刊物
- ☐ 在线形式的讲座、展览、会议
- ☐ 现场/面对面形式的讲座、展览、会议

☐ 商业推广/宣传性的印刷品

☐ 商业推广/宣传性的电子邮件

☐ 供应商、服务商的网站

☐ 政府发布的在线技术报告

☐ 行业/垂直网站

☐ 通过搜索引擎搜到的任何页面

提交问卷

Appendix G: Campus IRB Exempt Approval Letter

Campus IRB Exempt Approval Letter: IRB # 1111457

Dear Investigator:

Your human subject research project entitled FACTORS INFLUENCING CHINESE ELECTRONICS ENGINEERS¿ SELECTION OF INFORMATION SOURCES was reviewed and APPROVED as "Exempt" on March 24, 2008 and will expire on March 24, 2009. Research activities approved at this level are eligible for exemption from some federal IRB requirements. Although you will not be required to submit the annual Continuing Review Report, your approval will be contingent upon your agreement to annually submit the "Annual Exempt Research Certification" form to maintain current IRB approval. You must submit the "Annual Exempt Research Certification" form by February 07, 2009 to provide enough time for review and avoid delays in the IRB process. Failure to timely submit the certification form by the deadline will result in automatic expiration of IRB approval. (See form: http://irb.missouri.edu/eirb/)

If you wish to revise your activities, you do not need to submit an Amendment Application. You must contact the Campus IRB office for a determination of whether the proposed changes will continue to qualify for exempt status. You will be expected to provide a brief written description of the proposed revisions and how it will impact the risks to subject participants. The Campus IRB will provide a written determination of whether the proposed revisions change from exemption to expedite or full board review status. If the activities no longer qualify for exemption, as a result of the proposed revisions, an expedited or full board IRB application must be submitted to the Campus IRB. The investigator may not proceed with the proposed revisions until IRB approval is granted.

Please be aware that all human subject research activities must receive prior approval by the IRB prior to initiation, regardless of the review level status. If you have any questions regarding the IRB process, do not hesitate to contact the Campus IRB office at (573) 882-9585.

Campus Institutional Review Board

VITA

Qingchun Guo was born in Changchun, capital city of China's Jilin province in1966. He was enrolled in Peking University in 1984 and graduated in 1988 with a B.S. in Physics. The following year Guo began his graduate study at the Graduate School of Chinese Academy of Social Sciences and earned his M.A. in History in 1991. He worked as a research specialist in CASS's Institute of Archaeology for some years before he turned to book and magazine publishing. In 2000 he was accepted by the Missouri School of Journalism and earned his second M.A. 2001. Next year he began his doctoral study in the University of Missouri-Columbia School of Information Science and Learning Technologies. Guo returned to Beijing after he finished his comprehensive exams in 2005. He is now the Editorial Director of *Electronic Products China* magazine and 21IC.com.