Information search behavior and utilization of digital library of innovative consumers

Jane Lu Hsu
Professor
National Chung Hsing University
Taiwan

Livia Chia-Yen Chang
Graduate Research Assistant
National Chung Hsing University
Taiwan

This study was undertaken to examine digital library usage and to identify innovative users of digital libraries using data collected in four universities in Taiwan. The Domain Specific Innovativeness (DSI) scales were used in the study to segment respondents into various cluster of innovativeness in digital library usage. On average, college students spent 3.5 hours on digital libraries per week. The findings in this study indicated that 8.31% of digital library users could be classified as innovative users. They were frequent users and were familiar with services provided by digital libraries. Innovative users searched and downloaded more materials from digital libraries than respondents in other clusters. In general, journal/magazine articles were the most frequently used services for digital library users, while e-books were used much less often.

Digital library, Innovative consumers, Information search

Introduction

Digital libraries are a way for traditional libraries to utilize technology in digitalizing collections as well as providing services. As technologies emerged, digital libraries are referred to as "knowledge commons" (Ioannidis, 2005). The explanation of digital library indicated on website of National Science Foundation (NSF) is:

> Digital Libraries basically store materials in electronic format and manipulate large collections of those materials effectively. Research into digital libraries is research into network information systems, concentrating on how to develop the necessary infrastructure to effectively mass-manipulate the information on the Net.

Research on digital library systems started in Europe in the mid-1990s (Castelli, 2006). Digital library is the future of traditional libraries. As mentioned in Leiner (1998), digital libraries need to provide access to users in a manner fulfilling their needs, and further to provide services effectively under resource constraints.

Institute of Museum and Library Services (IMLS) described that digital technology facilitates digital services available in museums, libraries, and archives and that organized

and categorized materials makes accessibility to the public in a new way. Kani-Zabihi, Ghinea, and Chen (2006) mentioned that digital libraries enable users to access from anywhere at anytime through the internet.

The internet has changed the way how users search information. In Taiwan, more than 15 million people have access to the internet in early 2008 (Table 1). The demand for services provided by digital libraries is increased, and users may have diversified needs for information collected in digital libraries. Realizing how users perceive digital libraries and the services they need could be beneficial for digital libraries to improve the service quality as well as the service management.

Table 1 Internet Users in Taiwan (2004 to January 2008)

Year	Internet Users (million people)	Growth Rate (percent)
2004	12.64	
2005	13.80	9.2
2006	14.76	7.0
2007	15.23	3.2
End of January 2008	15.55	2.1

Source: Taiwan Network Information Center, Internet Broadband Usage in Taiwan

The Taiwan National Central Library had established its information system in 1982. In recent years, usage of the information system in the Taiwan National Library has increased from 2.0 persons to 5.2 persons on average per second (Table 2). The accessibility of digital libraries has increased. More users get acquainted with the services provided by digital libraries, which in turn drives digital libraries to enhance services for a broad range of users.

Table 2 Usage of Information System in Taiwan National Central Library (2005-2007)

Year	2005	2006	2007
Average Persons (per second)	2.0	3.9	5.2

Source: Taiwan National Central Library

According to the Association of Research Libraries (ARL) statistics, there is an increasing trend in expenditures on digital libraries of the university library members in ARL in recent years (Table 3). Certain categories like electronic serials cost more than other services. Since 2003, the digital expenditures had been highlighted in the ARL annual statistics to indicate the profound trend of information digitalization of university libraries.

Table 3 Digital Expenditures of University Members in the ARL (million USD)

Year	2003-2004	2004-2005	2005-2006
Expenditures on Computer Files	32.10	38.74	48.79
Expenditures on Electronic Serials	269.60	328.17	383.13
Expenditures on Computer Hardware and Software	65.80	91.79	68.66
Expenditures on Document Delivery/Interlibrary Loan	13.03	12.95	13.41

Source: Association of Research Libraries, ARL statistics

Digital libraries are convenient for users to search information. It is imperative to recognize that digital library usage is not restricted to knowledgeable users, but accessible to users with different information technology backgrounds (Kani-Zabihi, Ghinea, & Chen, 2006). Hence, services provided by digital libraries need to fulfill the needs of a variety of users. Borgman (2000) emphasized that the contemporary way was to develop technology for human needs instead of shaping human beings to become accustomed to the technology.

Easiness in the accessibility of the digital libraries affects information search behavior. Even with a large amount of users trafficking digital libraries, the question would be 'who are the users more likely to try new services provided by digital libraries?' Would there be innovative users of digital libraries? If there were innovative users of digital libraries, would there be any difference in the usage of digital libraries for innovative consumers from those who were likely to be late adopters of digital libraries?

Innovative consumers are unique in product and service marketing due to the roles innovative consumers play in influencing product and service diffusion. Rogers and Shoemaker (1971) stated that innovativeness was of individuals who were relatively early in adopting an innovation than other members in the system. Individuals went through several stages during the adoption process and then decided whether or not to adopt (Rogers, 1995). Since innovative consumers tend to be very early adopters, relatively young, and are likely to be opinion leaders seeking novel information (Chau and Hui, 1998), innovative users of digital libraries are imperative for service improvement and information dissemination of digital libraries, especially at the stage of launching new services.

Digital libraries are revolutionary versions of traditional libraries. With technological innovation, digital materials are stored and can be accessed through interfaces efficiently. However, for users who are not familiar with the usage of digital libraries, the usability can be largely reduced. Saaksjarvi (2003) mentioned that the interest towards innovation adoption would be influenced by users' past experiences and values as well as personal opinions in technological innovation.

In the relevant literature of digital libraries, information system designs were paid more attention to. Very limited research had studied in the area of usability and familiarity of the digital library services from the viewpoints of users. Since libraries are service providers, perceptions of users are of great importance in service management. Realizing who the users of digital libraries are and what kind of services they prefer using could be essential for digital libraries to improve the service quality. Whether innovative users of digital libraries exist and what the differences in characteristics of innovative users from late adopters of digital libraries would be practically imperative in service marketing of digital libraries. Bowden and Corkindale (2005) indicated that quantitative methods could provide certain details for researchers to know how innovators process information as well as making decisions. While the research on consumer traits has been useful for researchers to understand the characteristics of innovator, and also the domain specific research advances marketers to more effectively target consumer innovators. Hence, the objectives of this study are to identify characteristics of innovative consumers in the usage of digital libraries and further to examine whether the innovative consumers of digital libraries are more familiar with services provided in digital materials. The contributions of this study are to fill in the gap of research in digital libraries from users' perceptions and to provide managerial implications based on the findings of the study.

Digital libraries reside in an environment of constant change, from the information technology improvement and the diversified needs of users. The future of digital libraries is to meet expectations of users with quality assurance (Baker, 2006). Innovative users of digital libraries are more likely to be those who are attracted by innovativeness of services provided by digital libraries in information search. For managers of libraries, understanding the uniqueness of innovative users provides baselines in developing efficient communications. Identifying innovative users is critical for successful development of new services for digital libraries. The findings in this study are beneficial for further research theoretically as well as for managers of libraries empirically in the usage of digital libraries.

Methodology

Survey

A questionnaire was designed to collect user data in four universities in Taiwan. A trail survey was conducted prior to the formal survey. The questionnaire was modified based on suggestions provided by professionals and respondents participated in the trail survey. The formal survey was administered in December 2007 on campuses in four universities in Taiwan. Trained surveyors stood in front of student unions, cafeterias, or dormitories. Every on in ten to 15 students was approached, and the purpose of the survey was explained to the potential respondents. Rejection rate was approximately 10 percent, mainly due to time constraints of respondents.

Respondents needed to be full-time undergraduate or graduate students at the universities by the time the survey was administered, and had used the digital library at school at least once in the Fall semester to be eligible to participate in the survey. Trained surveyors provided necessary assistance to respondents in explaining the questions. A gift worth of approximately one US dollar was provided for respondents who were willing to participate in the survey. If for any reason respondents decided not to finish up the survey, the gifts were not retrieved and the questionnaires were discarded. The total surveyed respondents were 480, with 120 surveyed in each university. Male and female students accounted for roughly half of the surveyed respondents. Valid samples were 423, with 57 samples considered invalid due to incomplete or inconsistent answers.

Methods

Descriptive analysis, factor analysis, and cluster analysis were utilized in this study to examine characteristics of innovative users of digital libraries. Factor analysis is a multivariate approach used to reduce the dimensionalities of the variables and to analyze interrelationships among a large number of variables. In providing empirical estimates of the structure of the variables, factor analysis has been used to create summated scales on an objective basis (Hair *et al*., 2006).

Cluster analysis was utilized in this study to segment respondents into groups with similar characteristics. The purpose of cluster analysis is to classify individuals into classes or groups, so the individuals in the same class or group are similar to one another and the individuals in different classes or groups are dissimilar (Johnson, 1998). The *K*-means method of clustering is more suitable for large datasets and was applied in this study.

Results

Demographics of respondents

The valid sample consisted of 50.59% male students. The average age of respondents was 21.56. The respondents included students from freshmen to master's students with 63.83% undergraduate students and 36.17% graduate students, and from various majors in the colleges of art, science, engineering, agriculture, business, design, and education. The average monthly expenses of surveyed respondents were USD 262.64.

Usage of digital libraries

On average, respondents spent 1,802.02 minutes per week surfing online, including 212.85 minutes per week searching information in digital libraries (11.81% of total online surfing time). The average monthly usage of digital libraries was 7.46 times, higher than the average monthly usage (5.52 times) of brick-and-mortar libraries. In general, college students used digital libraries more often, and the time they spent on digital libraries was approximated 3.5 hours per week.

In order to know whether respondents were familiar with services provided by the digital libraries, self-evaluation of familiarity of digital libraries were measured. Ten points indicated the most familiar with specified service provided by the digital libraries, and one point indicated the lease familiar with. In the usage of digital libraries, journal/magazine articles were searched and downloaded more often than other collected digital materials (Table 4). E-books were searched and downloaded fewer times in digital libraries in universities. For theses, more items were searched than downloaded. Respondents seemed to be more familiar with theses and journal/magazine articles, and less familiar with the services of e-books. Moreover, respondents used more of those services provided in digital libraries that they were familiar with.

Table 4 Familiarity and Usage of Digital Libraries

	Familiarity	Times Searched (number of times/month)	Times Downloaded (number of times/month)
Theses	4.93	2.28	1.40
E-books	3.83	0.75	0.36
Journal/Magazine Articles	4.82	3.56	3.01
Multimedia Files	4.06	1.37	1.20

Note: Familiarity was measured using self-evaluated scales with ten points the most familiar and one point the least familiar. Respondents evaluated familiarities of the digital library at school.

In evaluation of digital libraries, the respondents were asked to rate completeness and convenience of digital libraries of the universities they were studying. Ten points would be the highest for completeness and convenience, and one point the lowest. The average score of completeness was 7.10 and the average score of convenience was 6.83. These results coincided with the familiarity of digital libraries of respondents. Since respondents were not totally familiar with collections of digital materials in the digital libraries (with the averaged score less than five); hence, the convenience of digital libraries were not highly rated.

User innovativeness

User innovativeness of digital libraries was measured using the Domain Specific Innovativeness (DSI) scales developed by Goldsmith and Hofacker (1991). Three positive worded statements and three negative worded statements were used with four-point Likert scales from one (disagree strongly) to four (agree strongly). Negative worded statements were coded reversely, and the scores of six DSI statements were summed into a total DSI score for each respondent. The DSI measurement was the only variable used in the clustering procedure to segment respondents into four different clusters.

Upon segmenting the respondents into various clusters of innovativeness, the users were classified as innovative users (8.31%), early adopters (47.27%), late adopters (39.67%), and laggards (4.75%). The average DSI score of innovative users was the highest (21.26), while of laggards was the lowest (9.90). Innovative users spent 14.72% of total online surfing time on information search information at digital libraries, and used the digital libraries more than 12 times a month on average. For innovative users, the familiarity of digital libraries was rated the highest among respondents in different clusters, especially the services of e-books and journal/magazine articles. Innovative users of digital libraries rated the completeness of digital libraries the highest. Although respondents in the cluster of laggards rated the convenience the highest among respondents in different clusters, they did not use digital libraries that much and were not that familiar with services provided in digital libraries. Although the ratings of completeness and convenience of digital libraries among respondents in different clusters were statistically insignificant, the lower rating of convenience by innovative users could be because that they had higher expectations on convenience. For occasional users like respondents in the cluster of laggards, digital libraries provided a way to obtain information without the need to go to the brick-and-mortar libraries, which would be convenient.

Table 5 Segmentation of Digital Library Users

	Innovative Users (n=35)	Early Adopters (n=199)	Late Adopters (n=167)	Laggards (n=20)	F Statistics
Respondents (%)	8.31	47.27	39.67	4.75	
DSI (Innovativeness)	21.26	17.29	13.75	9.90	839.79***
Online Surfing Time Used in Digital Libraries (%)	14.72	12.32	11.09	6.97	
Frequencies of Digital Library Usage (times/month)	12.73	8.24	5.82	4.10	13.99***
Evaluation of Completeness	7.17	7.07	7.10	6.90	0.13
Evaluation of Convenience	6.89	6.83	6.74	7.30	0.50
Familiarity					
Theses	5.89	5.14	4.66	3.50	3.45
E-books	4.43	3.98	3.72	2.20	4.44**
Journal/Magazine Articles	5.40	5.12	4.50	3.60	3.58**
Multimedia Files	4.63	4.22	3.76	3.80	1.52

Note: Evaluations of completeness, convenience, and familiarity were measured using self-evaluated scales with ten points the highest and one point the lowest.
** indicates significance at 5 percent significance level; *** indicates significance at 1 percent significance level.

Innovative users searched and downloaded more materials from the digital libraries. Frequent usage included collections of theses and journal/magazine articles. For a less used

service like e-books, the average times searched per month were 2.63, and the average times downloaded were 1.31 (Table 6). Early adopters and late adopters used the digital libraries not as much as innovative users, but the services of journal/magazine articles were used more often than other services. Laggards mainly used service of journal/magazine articles of digital libraries, and the quantities searched and downloaded were close to those searched and downloaded by late adopters. In sum, services of journal/magazine articles in the digital libraries are the most popular for users, followed by collections of these and multimedia files. The e-book services are much less searched and downloaded by users of digital libraries.

Table 6 Searching and Downloading Digital Materials from Digital Libraries

	Innovative Users (n=35)	Early Adopters (n=199)	Late Adopters (n=167)	Laggards (n=20)	F Statistics
Times Searched (#/month)					
Theses	6.26	2.44	1.37	1.40	9.58***
E-books	2.63	0.72	0.47	0.00	6.51***
Journal/Magazine Articles	10.86	5.27	3.15	3.15	7.67***
Multimedia Files	3.60	0.93	1.46	1.10	3.13**
Times Downloaded (#/month)					
Theses	3.83	1.44	0.94	0.75	6.88***
E-books	1.31	0.27	0.31	0.00	3.25**
Journal/Magazine Articles	9.56	4.25	2.83	2.74	6.19***
Multimedia Files	3.23	0.96	1.10	0.75	2.55*

Note: * indicates significance at 10 percent significance level; ** indicates significance at 5 percent significance level; *** indicates significance at 1 percent significance level.

Conclusion

This study was undertaken to examine digital library usage and to identify innovative users of digital libraries using data collected in four universities in Taiwan. The Domain Specific Innovativeness (DSI) scales were used in the study to segment respondents into various cluster of innovativeness in digital library usage. On average, college students spent 3.5 hours on digital libraries per week.

The findings in this study indicated that 8.31% of digital library users could be classified as innovative users. They were frequent users and were familiar with services provided by digital libraries. Close to 15% of online surfing time of innovative users was spent on information search in digital libraries. Evaluations of completeness and convenience of digital libraries were statistically insignificant among respondents in different cluster, although innovative users rated completeness of digital libraries higher than respondents in other clusters. Innovative users searched and downloaded more materials from digital libraries than respondents in other clusters. Journal/magazine articles were the most frequently used services for digital library users, while e-books were used much less often in digital libraries.

Managerial suggestions for digital libraries are:

1. Provide education programs for current and potential users to get acquainted with services of digital libraries. Only when users are familiar with the services in the digital libraries, the usability could be enhanced.

2. Design website of digital libraries easy for naïve users to surf. Some search techniques need practice to know how to search efficiently. Naïve users could be frustrated if not be able to search or download the materials when they need to.

3. Encourage users to use digital libraries by creating specially designed marketing activities to attract users to try newly established services.

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Biographical Notes

Jane Lu Hsu is a professor in the Department of Marketing at National Chung Hsing University in Taiwan. She received a Ph.D. in Agricultural Economics from Kansas State University in the US in 1996. Her research interests include consumer studies and information marketing.

Livia Chia-Yen Chang is a graduate research assistant in the Department of Marketing at National Chung Hsing University in Taiwan. Her research interests include consumer behavior and information marketing

Statement of Originality

This statement certifies that the paper above is based upon original research undertaken by the authors and that the paper was conceived and written by the authors alone and has not been published elsewhere. All information and ideas from others is referenced.