The Electronic Library

Evaluation of digital libraries of Iranian research institutions based on the DigiQUAL protocol
Mehdi Alipour-Hafezi Hamid Amanollahi Nick

For Authors

If you would like to write for this, or any other Emerald publication, then please use our Emerald for Authors service information about how to choose which publication to write for and submission guidelines are available for all. Please visit www.emeraldinsight.com/authors for more information.

About Emerald www.emeraldinsight.com

Emerald is a global publisher linking research and practice to the benefit of society. The company manages a portfolio of more than 290 journals and over 2,350 books and book series volumes, as well as providing an extensive range of online products and additional customer resources and services.

Emerald is both COUNTER 4 and TRANSFER compliant. The organization is a partner of the Committee on Publication Ethics (COPE) and also works with Portico and the LOCKSS initiative for digital archive preservation.

*Related content and download information correct at time of download.

Evaluation of digital libraries of Iranian research institutions based on the DigiQUAL protocol

Mehdi Alipour-Hafezi
Iranian Research Institute for Information Science and Technology, Tehran, Iran, and
Hamid Amanollahi Nick
Islamic Azad University, Hamedan, Iran

Abstract

Purpose – The purpose of this study is to identify the situation of evaluating Iranian digital libraries using DigiQUAL protocol.

Design/methodology/approach – Evaluative survey research method is used in this study to assess digital libraries. In this way, digital libraries of Iranian research institutes constitute the study population. DigiQUAL protocol actually was used to evaluate eight Iranian digital libraries. Systematic observation and interview based on researcher-made checklist was used for data collection. In fact, checklist was constructed based on DigiQual protocol.

Findings – The results showed that Digital Library of Isfahan Science and Technology Town has the best performance and Noor digital library has the lowest operation in studied digital libraries. The overall score of all studied digital libraries was under 60 (out of 100) which shows the average performance of the digital libraries.

Originality/value – This study emphasizes on evaluating active digital libraries in Iran by DigiQUAL protocol. Because digital libraries are new in Iran and their progress need to evaluate their activity, this research was done to demonstrate their situation.

Keywords Evaluation, Information systems, Libraries, Digital libraries

Paper type Research paper

Introduction

Obtaining access to information is the mission of libraries. Regardless of content or technology, libraries exist to provide a community with access to information (Buckland, 1992). In recent years, technological advances have played a prominent role in the field of libraries and, consequently, digital libraries (DLs) have emerged to improve our access to information. In fact, DLs have a significant position in research institutes and their services are critical for research activities. Services provided require assessment to be upgraded and the evaluation of DLs is specifically important due to the role they play in research activities.

DLs can be considered from several perspectives. They may be introduced as new forms of information institutions, as multimedia information retrieval systems or as systems that support knowledge production, organization and the search and retrieval

of digital contents. However, DLs have further applications, such as proper tools for digital asset and investment management, electronic commerce, electronic publishing and electronic learning (Borgman and Rasmussen, 2005). Advances in the information systems of DLs have evolved information access and communication methods, as well as the concept of libraries, beyond physical boundaries (Hassanzadeh, 2002). The information sources of DLs enable common users – not just librarians – to produce, edit and disseminate new information collections. Regardless of various definitions and interpretations, important questions still abound. Are these libraries as efficient and effective as needed? Are pre-defined objectives being reached? Numerous other questions may be raised in this same context. A vital area of concern is how to answer these questions. It is noteworthy that providing appropriate answers to such questions requires the review of processes and their results. Assessing DLs is a common practice and many efforts have been made in this regard (Van House *et al.*, 1996). Evaluations are still in their infancy, with only the determination of time and method having been studied so far (Xie, 2006; Saracevic, 2000); however, studies about DL evaluations have also been followed. As Shiri (2003) asserts, the emergence of DLs and their developments have opened new horizons on issues related to the design, implementation, development and evaluation of DLs.

Fuhr *et al.* (2007) also believed that DLs are new information systems that are continuously evolving, so their evaluation is vital in determining how much they are accepted by users and how efficient and effective they are. Thus, DLs need to be periodically reviewed and revised in projects, systems, policies, services and programs to achieve added value and further developments. Therefore, achieving a dynamic and efficient DL with expected stages like planning, design and implementation needs efficient and proper measures (Bishop, 1998). Taking proper measurements necessitates applying appropriate criteria for continuous evaluation and improvement of DL processes. In this regard, the main elements of DLs must be identified. Accurate study from different aspects helps in the identification of proper field criteria for DL assessment, as well as having acceptable results in the different stages of design and implementation.

As mentioned by Vullo (2010) and Saracevic (2000), a variety of approaches are used to evaluate DLs; content, technical, service and user-based approaches. Each approach tries to evaluate DLs in some aspect based on the evaluation goals. There are several different evaluation methods, such as: PEAK (pricing electronic access to knowledge) (Saracevic and Covi, 2000), Equinox[1], LibQUAL, DigiQUAL, eVALUEd[2], COUNTER (counting online usage of networked electronic resources)[3] (Jose, 2007), MINES (measuring the impact of networked electronic services) (Kyrillidou and Cook, 2008), 5S (streams, structures, spaces, scenarios, societies) (Gonçalves *et al.*, 2004), QFD (quality function deployment) and Kano (Garibay *et al.*, 2010), that can be used to evaluate DLs. Despite using these approaches and models, we as assessors do not know at all how to evaluate a DL as a whole (Saracevic, 2009).

DigiQUAL was tested as a short online survey containing five questions and a comments box. It systematically collects feedback on the site's service, functionality and content. Survey questions are randomly drawn from an item bank of more than 180 items that have been developed through extensive qualitative analysis of focus group data and interview scripts with various DL developers and users (Kyrillidou and Cook, 2008). The purpose of this study is to identify the situation of Iranian DLs using the
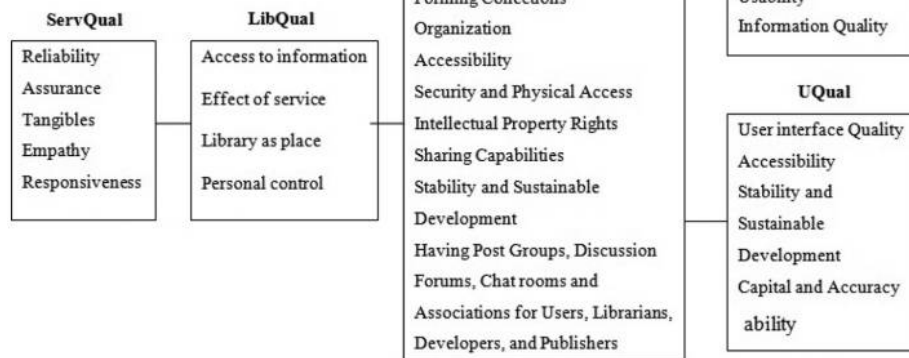
DigiQUAL protocol. To achieve our purpose, the following objectives regarding the Iranian DLs will need to be achieved:

- identify the quality of their Web environment;
- their search and browse capabilities;
- their methods of collecting data;
- their way to organize digital materials;
- their accessibility, their security and access control;
- the extent of their copyrights, their capability in sharing and collaboration;
- their perspective of sustainable development; and
- finally, the formation of their user communities.

The development of DLs, as a system, is essential. Also, evaluation is a reliable method for ensuring the healthy development of a system. Due to the necessity of overall evaluation of DLs and to determine the quality of content, structure and services of the DLs in Iran's research institutions, the DigiQUAL protocol was used in this study. This protocol was developed by ARL (Association of Research Libraries, 2005). The criteria in this protocol are very similar to those used in the LibQUAL protocol – used in the evaluation of traditional libraries (Kyrillidou *et al.*, 2009). In principle, both protocols have been developed based on the theory of service quality gap known as ServQUAL that is an instrument for measuring the gap between customers' expectations (users) and the quality of services provided (Kyrillidou and Cook, 2008). After four years (from 2000 to 2003) of implementations and ongoing qualitative and quantitative follow-ups, LibQUAL was introduced as a scalable, Web-based and comprehensive standard for measuring the quality of services in traditional libraries (Kyrillidou and Giersch, 2005). Thus, it is possible to use DigiQUAL as a standard model for evaluating DLs (Figure 1).

Accordingly, based on the main components of the DigiQUAL protocol, fundamental questions[4] addressed in this study that are the basis for the checklist, are as follows:

Q1. How attractive is the Web environment (design format) in the studied DLs?

Q2. How searchable are the studied DLs?

Q3. How browse-able are the studied DLs?

Q4. How are data collections gathered in the studied DLs?

Q5. How are resources organized in the studied DLs?

Q6. How accessible are the studied DLs?

Q7. How are the studied DLs secured and access-controlled?

Q8. How are intellectual property rights organized in the studied DLs?

Q9. How capable are the studied DLs in sharing and collaboration?

Q10. How are the studied DLs organized from the perspective of sustainable development?

Q11. How is the formation of user communities considered in the studied DLs?

DigiQual

Web Attractiveness
Search-ability
Brows-ability
Forming Collections
Organization
Accessibility
Security and Physical Access
Intellectual Property Rights
Sharing Capabilities
Stability and Sustainable
Development
Having Post Groups, Discussion
Forums, Chat rooms and
Associations for Users, Librarians,
Developers, and Publishers

WebQual

Interaction Quality
Overall impression
Usability
Information Quality

UQual

User interface Quality
Accessibility
Stability and
Sustainable
Development
Capital and Accuracy
ability

ServQual

Reliability
Assurance
Tangibles
Empathy
Responsiveness

LibQual

Access to information
Effect of service
Library as place
Personal control

Figure 1.
The evolution of
protocols for
evaluating service
quality in academic
and research libraries

As per the aforementioned points, this study attempts to fully evaluate Iranian research institute DLs to exploit the final results in planning their more efficient development.

Research background

There have been several attempts to evaluate design, implementation and use of DLs. Most of them cover the initial assessment of why users have chosen the digital environment and how data have been entered in the design and development cycle (Marchionini, 2000; Saracevic, 2000, 2004; Blandford *et al.*, 2004a, 2004b). However, little has been done to assess DLs specifically in educational, research and learning areas; and also the evaluation methods cannot be considered as prominent. The most important preventive factors are the distribution-based nature of DLs, as well as the lack of proper criteria, methods and tools for assessment.

Saracevic (2000, p. 368) warned that "some research efforts have been conducted on the DL domain, but the issue of evaluation has apparently been neglected". Since then, the field of evaluation has seriously advanced, so that after half a decade, Chowdhury *et al.* (2006, p. 658) stated that "although in the first period of digital libraries development, few evaluative studies can be seen, this field has especially been considered during the last 5 years". Currently, most research on DL evaluation is based on traditional library systems, information retrieval (IR) systems, human–computer interaction (HCI), digital technologies and so on (Marchionini, 2000).

Most of the studies in the field of DLs' evaluation investigate the applicability of DLs (Xie, 2006, p. 434). By definition, applicability means "the use of a particular product by specific users to achieve specified goals in a particular context with satisfaction, effectiveness and efficiency". According to Dalrymple and Zweizig (1992) and Blandford *et al.*, 2004a, 2004b, the purpose of usability evaluation is to assess how users interact with predetermined plans and understand their reactions such as satisfaction, usefulness, value, frustration and efficiency. Among the studies on applicability, Van House *et al.* (1996) and Bishop *et al.* (2000) tried to understand the users' needs, identify

their current problems and favorite characteristics and assess the overall users' satisfaction.

Other studies assessed the usability of DLs through links to users' pages. The findings of research on students of electronic learning courses in universities in Iran showed that the applicability criteria of DLs are understandability of concepts in users' linked pages, Web page characteristics and the clarity of leading applications (Majidi *et al.*, 2010). Although the quality of assessment has not been considered in literature, providing qualified services to users is the researchers' main concern (Isfandyari-Moghaddam and Bayat, 2008). Gonçalves *et al.* (2007) noted that the evaluation of quality in DLs is an ignored issue. Earlier theoretical works such as Saracevic (2000), Poll (2001) and Fuhr *et al.* (2001) assessed quality dimensions, including availability, accuracy, completeness, constructability, conformance, consistency, effectiveness, efficiency, extensibility, pertinence, preserve-ability, reliability, reusability, significance, similarity and timeliness. They also considered the following characteristics: response time (with regard to efficiency), cost of migration (with respect to preserve-ability) and the number of system service failures (to assess reliability). In fact, they offered a qualitative model for DLs posing the question "How would this be a good DL?"

It is noteworthy that all of the research efforts have studied DL systems from different non-comprehensive views. In this context, Saracevic (2005) stated that there are no comprehensive standard criteria for evaluating DLs. Thus, evaluators have used their own evaluation criteria. Consequently, available criteria are disparate and fluctuating.

After nearly 10 years, we modify Saracevic's (2004) statement that "everything about digital libraries is explosive, except for one thing: assessment" as follows: everything about DLs is explosive, except for one thing: evaluation using methods except applicability, or, to be more precise, using the multi-dimensional evaluation method.

To obtain an understanding of the current situation and gather user needs, a multi-faceted evaluation method is needed. According to the information economy, the value of information increases through its usage. This rule also applies in the case of DLs. Hence, such an approach (multi-evaluation method) would help designers and developers of DLs. This attitude is consistent with McClure and Bertot (2001), Snead *et al.* (2005) and Bertot *et al.* (2006). In fact, they believe that "multiple approaches are far better in identification and assessment of real needs of users". Thus, it seems that the integration of methods in one single frame – we call it "evaluation with multiple approach" – would be helpful.

A summary of studies evaluating DLs are best covered by Barton (2004). She mentioned that while the standards and assessment methods of traditional library services are well-identified and fixed, metrics of evaluating DLs standards has not grown considerably. Therefore, it is fair to say that DL evaluation strategies are still relatively new.

Considering the above, it can be concluded that research in the area of DL evaluation does not provide specific solutions to integrate the processes of design, production and implementation of DLs. Only such a solution may solve the problems of making collections, organization and management of intellectual property rights, searching and retrieval of non-print informational sources and controlling the heavy costs of

converting print resources to digital resources, as well as providing better services and intra-libraries interactions in the vast environment of the WWW.

According to the research reviewed, the DigiQUAL protocol is a comprehensive, thorough tool for DL evaluation. In fact, it covers all aspects of DLs. DLs are systems that are in direct interaction with scientific users, especially in research institutes. Also, they as a systems are in need of development and assessment is on the way to development. Thus, evaluating DLs is essential. Therefore, this study evaluates DLs using the DigiQUAL protocol.

Research methodology

This study is an evaluative survey conducted in 2011-2012 on eight active DLs in Iranian research institutions. Given that research institutions are always pioneers in providing DL services, this study considers them as the leading DLs in the country. The libraries, listed below in Table I, are: the Digital Library of Iran Electronics Industries (IEI), the Noor Digital Library (NDL), the Tebyan Digital Library (TDL), the Digital Library of the Research and Publishing Institute of Ahl-e-Beit (RPIAB), the Digital Library of the Iran Industrial & Scientific Research Organization (IISRO), the Digital Library of Isfahan Science and Technology Town (ISTT), the Digital Library of the Information Science and Technology Research Institute (ITRC) and the Digital Library of the Iranian Research Institute for Information Science and Technology (IRIIST). These DLs were all of the active ones in Iran when this study was performed. Because the goals of these institutes were the same and a limited area was selected in this research (Iran), the study population was limited to the abovementioned eight DLs.

Many evaluative approaches, orientations, levels and objectives are used to evaluate DLs. Also, different approaches have been used for different evaluation goals. Saracevic (2004) mentioned some approaches applied by a number of studies: systems-centered, human-centered, usability-centered, ethnographic, anthropological, sociological and economic approaches. However, classifying them uses the following four categories: content-based, technology-based, service-based and user-based approaches (Vullo, 2010). The DigiQUAL standard protocol was chosen to measure Iranian research institutes' DL services because of its consistency with the approach of this study in evaluating DL services. In this regard, systematic observation and interviews based on the researcher-made checklist was used to gather information. Indeed, the checklist was prepared based on the DigiQUAL protocol. Moreover, works such as Goh *et al.* (2006), Kyrillidou and Giersch (2005) and Fuhr *et al.* (2001) were used to complete the checklist.

Names	Acronyms
Iran Electronics Industries	IEI
Noor	NDL
Tebyan	TDL
Research and Publishing Institute of Ahl-e-Beit	RPIAB
Iran Industrial & Scientific Research Organization	IISRO
Isfahan Science and Technology Town	ISTT
Information Science and Technology Research Institute	ITRC
Iranian Research Institute for Information Science and Technology	IRIIST

Table I.
The names of and acronyms for the studied digital libraries of Iran

Therefore, the checklist was provided to some DL experts and exploited after necessary revisions. Consequently, the checklist was composed of two parts: one to be answered by DL managing directors and the other part to be completed by researchers. In this way, interview sessions were held with managers of the abovementioned DLs. For this purpose, in separate meetings with managers of DLs, the questions related to managers were asked and their statements were recorded by voice recorder. Afterwards, the recorded sessions were transcribed into text files, and were then tagged and analyzed by the researchers[5]. The results were entered into tables separately for each DL to categorize extracted data[6]. Consequently, the data were categorized as criteria and sub-criteria individually for each DL, and merged with each other when necessary.

In the next step, the researchers referred to DLs' Web portals and collected data by using the checklist. Therefore, systematic observation is used to collect data in the second part of the data collection. Findings in this section were transferred to tables to categorize them as mentioned above. As mentioned, the first two methods are used to collect data and the third method is used to complete data collection and, also, to assess the collected data. In some cases, some of the findings were corrected during the researchers' observation.

In all, the evaluation was conducted by criteria of different values based on the DigiQUAL guidelines. The assessment tool consists of eleven key criteria (Table II) and each is highly privileged depending on its importance. The total score of these eleven criteria are equal to 100 points. Numbers and percentages listed against each criterion represent a significant share of the total score.

Analyzing the classified data in the tables helped us to answer the research questions. Also, answering the research questions helped us to answer the main question and reach the main purpose of the research.

Findings
In this part, the findings gathered through the checklist, interviews and systematic observations are described. The content structure of this section is based on the fundamental questions raised in this study previously.

Criteria name	Criteria point
Web attractiveness	8
Searchability	12
Browsability	4
Forming collections	12
Organization	12
Accessibility	8
Security and physical access	8
Intellectual property rights	8
Sharing capabilities	10
Stability and sustainable development	8
Having post groups, discussion forums, chat rooms and associations for users, librarians, developers and publishers	10

Table II.
DigiQUAL main criteria and each share from the total points possible

Q1. How attractive is the Web environment (design format) in the studied DLs?
To answer this question, a benchmark study of four sub-criteria was conducted in the studied DLs, such as transactions, navigation services, referral services and simplicity or lack of complexity. These four criteria and their sub-criteria are shown in Figure 2.

All the studied DLs try to design the user's DL Web page as simply as possible. Also, all of the studied DLs have criteria of simplicity, except ISTT that missed one factor: clarity in asserting the library name or mother organization in its Web site or portal. Among the studied DLs, ISTT and IRIIST have more referential services; and three DLs, NDL, TDL and IISRO, obtained 75 per cent of the total score of the leading services (means 1/2 of 1/6 points).

Also, in all the studied DLs, users' contact lines to librarians, managing directors and related staff is only via e-mail or via commenting on the site. None has simultaneous transactions for communication and support. This makes it difficult to make direct connections with users.

Q2. How searchable are the studied DLs?
To answer this question, three sub-criteria such as search options of DLs, possibility of sorting search results and fields provided for query by DLs were reviewed and analyzed (Table III).

As shown in Table III, the studied DLs offer different search fields to users. Meanwhile, the DLs of ITRC, RPIAB and IRIIST do offer all mentioned fields in the assessment tool. Providing three fields for sorting out search results, RPIAB and IRIIST offer the most number of fields to their users. Also, the DL of IRIIST provides eight options of considered items in the assessment tool and obtains the highest point in this regard. After this library, the highest points reached are RPIAB, ISTT and ITRC,
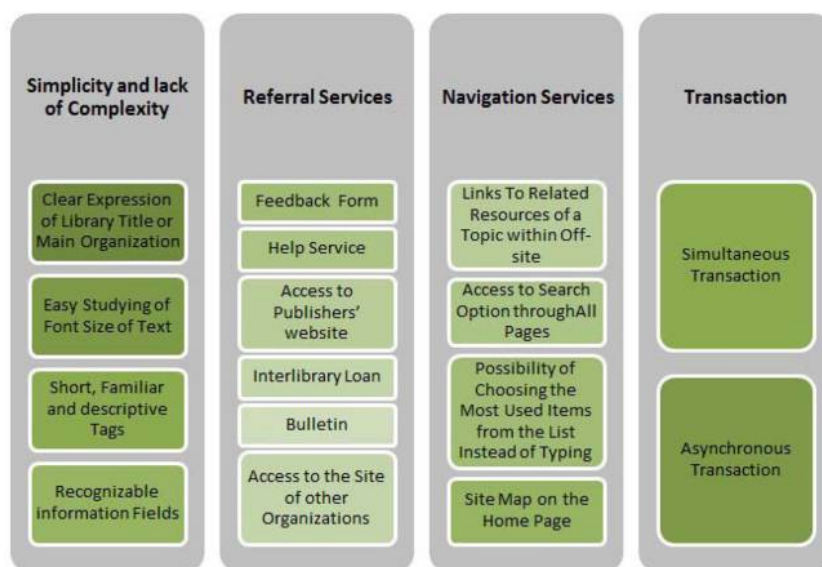
Figure 2.
Web attractiveness
criteria

Digital libraries	Search fields	Sorting out search results	Search options
IEI	Author, title, more than one field	Based on date	Simple, advanced, phrasal, proposing related keywords
TDL	Author, title, more than one field	Based on title, evidence type	Simple, advanced, phrasal, similarity finding, privatization of search results
NDL	Author, title, more than one field	–	Simple, advanced, phrasal, Boolean
RPIAB	Author, title, more than one field	Based on title, author	Simple, advanced, phrasal, Boolean, similarity finding, index review
IISRO	Author, title, more than one field	Based on title, author	Simple, advanced, phrasal, similarity finding, proposing related keywords
ISTT	Author, title, more than one field	Based on title, author	Simple, advanced, phrasal, Boolean, proposing related keywords, index review
ITRC	Author, title, more than one field	Based on title, author, date	Simple, advanced, phrasal, Boolean, similarity finding, index review
IRIIST	Author, title, date, evidence type, more than one field	Based on title, author	Simple, advanced, phrasal, Boolean, proposing related keywords, index review, privatization of search results

Table III.
Search features in the studied digital libraries

providing 50 per cent (six items of the considered assessment tool) of services to their users.

Q3. How browse-able are the studied DLs?
To answer this question, we examined the fields that DLs of the research community provide their users (Tables IV and V).

The studied DLs are relatively highly browsed, as all the studied DLs have at least 50 per cent of the total points possible. Meanwhile, allocating six search fields of the total eight predetermined in the assessment tool, the DLs of RPIAB and ITRC obtain the highest rating.

Q4. How are data collections gathered in the studied DLs?
To answer this question, three criteria of making collections in studied DLs – methods of gathering sources in DL, format of available digital items and other specifications – were examined. The common text format in studied DLs is Unicode. Except the DL of IEI, all studied cases use this format. All DLs use PDF as the demonstration format. Only in the IEI Digital Library is access to the previous editions of documents provided for users. All studied DLs have pre-defined approaches for data collection and consider users'

informational need as well as their organizational goals. Also, three DLs (IEI, ISTT and ITRC) reduce their file size for easier loading.

Q5. How are resources organized in the studied DLs?
To answer this question, first, we study descriptive metadata standards used in all the DLs and, then, through a sub-criteria, existence or non-existence of organization possibilities were reviewed. With five cases, MARC has the highest frequency. Three libraries use Dublin Core, three use MODS and one uses METS as the standard format. Research findings show that five of the DLs – those of IEI, NDL, TDL, ISTT, as well as IRIIST – have the possibility of indexation and access to metadata through search engines. Software in all the studied DLs, except TDL, has the capability of collective entrance of data and documents controlling for individuals. All DLs, except NDL, have the list of subject top titles in their software. IISRO and IRIIST provide automatic indexation of sources content through the software.

Q6. How accessible are the studied DLs?
To answer this question, we examined the four criteria relating to the availability of access in studied DLs (Table VI).

Among the studied libraries, four libraries provide specific services to users with visual or audio disabilities. Also, in all the studied libraries, people who have color vision deficiencies may access all kinds of content, as the DL site is not confined to specific

Digital libraries	Content in alternative formats	Independence from specific colors	Clear mechanism	Appropriate and nice transfer of tables' content
IEI		*		*
TDL		*	*	*
NDL		*	*	*
RPIAB	*	*	*	
IISRO	*	*	*	
ISTT		*	*	*
ITRC	*	*	*	
IRIST	*	*		

Note: *Signifies tick sign (✓)

Table IV.
Evaluation of
accessibility of the
studied digital
libraries

Digital libraries	Browse fields
IEI	Subject, title, date, author, simultaneous browsing of multiple sources
TDL	Subject, title, date, author
NDL	Subject, title, source type, author
RPIAB	Subject, title, source type, date, author
IISRO	Subject, title, author
ISTT	Subject, title, source type, author
ITRC	Subject, title, source type, date, author
IRIIST	Subject, title, author

Table V.
Fields used for
browsing in the
studied digital
libraries

colors to display its content. Six DLs are designed so that users with cognitive and learning disabilities can use the site and, in four libraries, users with visual problems can view a table of content using magnification levels.

Q7. How are the studied DLs secured and access-controlled?
To answer this question, security and access control were examined across the three areas of access control, password management and user management (Table VII).

All the DLs control user access to the library through encryption. Also, all DLs limit user access to the DL based on their role. All the studied DLs – except RPIAB and ITRC that set passwords for their users – let users choose their own passwords. All the libraries let users change passwords chosen by users or the DL system. Except for the ITRC Digital Library, users are able to retrieve a forgotten password. Also, users have the ability to create their own profile and manage their actions in all of the DLs.

Q8. How are intellectual property rights organized in DLs?
One of important issues that DLs should care about is respect for intellectual property rights. This question tries to identify the situation of the studied DLs.

Because obeying copyright is obligatory worldwide, studied DLs should consider this point more seriously to reach global standards. In METS and Dublin Core, there is also an element for this indicator. The findings also show that the studied DLs do not meet the standards in this criterion.

User access control methods	Password management	User profile management
Encryption	Possibility of choosing a password by users	Possibility of creating a user profile
Digital signature	Possibility of changing a password by users	Possibility of changing a user's profile
Limited access by user-like intruders	Possibility of the revival of a forgotten password	Possibility of omitting a user's profile

Table VI.
The criteria and sub-criteria of evaluation in terms of security and access control

Digital libraries	Providing the author of all digital items	Clarifying the status of all digital items as free or chargeable	Access limitation based on copyright law	Formation of a group for managing discussion with users about obeying copyright
IEI	*		*	
TDL	*		*	
NDL		*	*	
RPIAB		*	*	
IISRO	*		*	
ISTT	*		*	
ITRC	*	*	*	
IRIIST		*	*	

Note: *Signifies tick sign (✓)

Table VII.
Status of digital libraries in terms of intellectual property rights

Q9. How capable are studied DLs in sharing and collaboration?
To answer this question, a review of agreements that DLs use to share and collaborate at national and international level was conducted.

Table VIII indicates that among all the studied DLs, six libraries use Z39.50[7] protocol for sharing and collaboration at national and international levels. It is worthy to say that just one of them could serve as the server side of the protocol and the others could not support it and only serve as the client side. Thus, the results show that the DLs could not share their content and just can use other shared information at the metadata level. Meanwhile, NDL uses no agreement for sharing and cooperation. In fact, just one of them, IEI, uses OAI protocol in this context.

Q10. How are studied DLs organized from the perspective of sustainable development?
Stability and the sustainable development of DLs were measured according to the parameters listed in Table IX that also shows the status for each of these parameters in the studied DLs.

Among the studied DLs, IEI, ISTT and IRIIST have the most points in the criteria of stability and sustainable development. These DLs have obtained 100 per cent – an eight out of eight – score. Next, the DLs of NDL, TDL and RPIAB, having four items of the total eight, obtained 6.5 points. And, finally, the DLs of ITRC and IISRO received a five score out of the total eight possible.

Digital libraries	Cooperation and source-sharing agreements
IEI	OAI
TDL	0.3950
NDL	–
RPIAB	0.3950
IISRO	0.3950
ISTT	0.3950
ITRC	0.3950
IRIIST	0.3950

Table VIII. Status of digital libraries from the perspective of source-sharing agreements

Digital libraries	Funding for future developments	Supported by mother company	Continuous development of infrastructures	Having a project management team	Supporting assessment plans
IEI	*	*	*	*	*
TDL	*	*	*		*
NDL	*	*	*		*
RPIAB	*	*	*		*
IISRO	*	*	*		
ISTT	*	*	*	*	*
ITRC	*	*	*		*
IRIIST	*	*	*	*	*

Note: *Signifies tick sign (✓)

Table IX. The status of the studied digital libraries regarding stability and sustainable development

836

Q11. How is the formation of user communities considered in the studied DLs?
Table X indicates that among all studied libraries only the DLs of TDL, IISRO and IRIIST provide communication facilities among users, librarians, developers and publishers. TDL has social networking, IISRO has launched chat rooms for communication between users and IRIIST has an association for professionals', scholars' and researchers' membership.

Figure 3 shows the overall status of the DLs regarding the total score earned from the 11 assessment tools.

As shown in Figure 3, all the studied DLs were under 60 per cent of the assessment tool score, indicating their weakness. The diagram also indicates that the best performance is claimed by ISTT – at a 59.1 score out of a total of 100 – that uses PAYAM Digital Library Software. The weakest performance is by NDL – at a 48.7 score – that uses its on-site developed software.

Discussion and conclusion
DL information systems have the potential to empower users, as well as librarians, to produce, assemble and disseminate new information collections. Many limitations to information have been removed by the emergence of DLs and simultaneous access to a

Digital libraries	Having chat rooms	Having discussion groups	Having social networks	Having think tanks	Having various communities
IEI					
TDL			*		
NDL					
RPIAB					
IISRO	*				
ISTT					
ITRC					
IRIIST					*

Note: *Signifies tick sign (✓)

Table X.
The possibility of user membership in communities, social networks, discussion groups and think tanks through the studied digital libraries
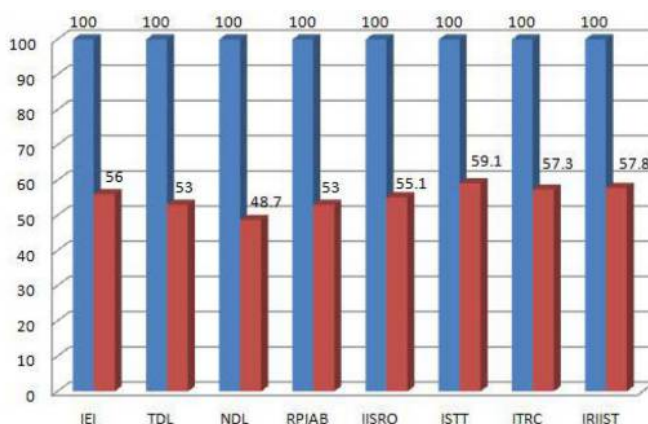
Figure 3.
Overall rating of each digital library regarding DigiQUAL

specific source for numerous users has been made possible (Noruzi and Alipour-Hafezi, 2001); however, inappropriate design and ignoring essential criteria and standards cause new problems. Therefore, to prevent such challenges and to encourage the development of DLs, it is more than ever important to continually evaluate DLs. Due to the multi-dimensional nature of DLs, this research approach for evaluating DLs is consistent with McClure and Bertot (2001), Snead *et al.* (2005) and Bertot *et al.* (2006). The authors advocate for multiple approaches to assessment as several methods are able to more effectively identify and assess the real needs of users.

The findings of this study demonstrate that, although various studies have been conducted to assess Web design characteristics and linked data – for example, Noruzi (2011) and Majidi *et al.* (2010) – all detailing the importance of these factors in attracting users and their applicability to DLs, many problems still exist in navigation and referral services. Under such circumstances, access to information would be challenging. Thus, it is suggested that the studied DLs need to identify the precise structural and visual elements on their Web site or portal that need to be updated. None of the studied DLs provide direct and simultaneous transaction service – online question-and-answer between librarians and users. So, providing a virtual reference desk through chat or video-conference equipment is suggested for direct and no-delay communication between users and librarians. These services and other interactive services could help DLs to improve their quality of services and also their user's satisfaction.

In DLs, due to the invisible nature of the physical resources, search abilities are increasingly important. To be more useable by their patrons, each DL should provide search and retrieval facilities. Offering features such as advanced search, related keywords, refining and ontological search, rankings and search-able fields and browsing, as well as providing more search fields, can increase search recall and precision, which ultimately increases user satisfaction with search results. Therefore, it is suggested that DLs analyze the search characteristics of their users and incorporate this data into developing the capabilities of their system. This would also improve user access to needed information. Consequently, search, browse and retrieval abilities in DLs make the resources accessible and enhance user satisfaction. Thus, the studied DLs should care more about these facilities and simplify them and, thereby, make them more user-friendly.

The results also show that ignoring intellectual property rights by users, as well as DLs have caused publishers not to be interested in publishing their works in electronic versions or even in selling licenses for their electronic publications, if they release these, to libraries. As a result, publishers and distributors provide direct access via licenses for users. Consequently, they do not sell the material anymore and licensing has replaced ownership in many cases (Clomb *et al.*, 2012). DL can use metadata standards such as METS, Dublin Core and so forth that have appropriate indicators to ensure the maintenance of copyright obligations and to increase the richness and production of numerous electronic versions of DL collections.

Referring to other DLs and information resources to meet the information needs of the user community is one of the ways to confront resource limitation in one DL alone. This study showed that most of the studied DLs use the Z.3950 protocol for resource-sharing and cooperation. Due to the client/server nature of this protocol, all of the studied library systems use its "client" side, but are not able to provide data for other information systems. Therefore, connecting DLs and collections requires more

advanced communication protocols and standards to ensure interoperability. The results of this study, as well as research by Alipour-Hafezi (2009), shows that efficient management of large volumes of digital metadata schema requires the creation and use of standard and consistent formats for metadata and organizing information in all digital projects. It is suggested that DLs use MODS or Dublin Core metadata standards to organize their information. This could help DLs to provide interoperability and to become members of an integrated group of DLs.

The results also show that most of the studied DLs have not considered any facilities for communication among users, librarians, publishers and developers. In this regard, providing user-friendly services in DLs through Web facilities, such as social media, is suggested to improve communication and cooperation with users.

In general, this study evaluates the content, services and performance of DLs in research institutes in Iran. The DigiQUAL protocol was selected to evaluate the DLs because of its comprehensiveness and relatedness to the libraries in this study. The results show that, based on the DigiQUAL protocol, the score of all of the studied DLs is under 60 (out of 100) which indicates their average performance compared to the DigiQUAL global standard. Therefore, Iranian DLs must try to reach global standards through more consistent equipment and the increased development of their infrastructure, as well as funding necessary budgets to reach these goals.

Notes

1. A project funded under the Telematics for Libraries Program of the European Commission.

2. The eVALUEd Project, housed within the evidence base at the UCE Birmingham, was set up to develop a transferable model for e-library evaluation in higher education, and to provide dissemination and training in e-library evaluation.

3. COUNTER was formally incorporated in England as a not-for-profit company, Counter Online Metrics.

4. Due to the similarity of these questions and the research objectives, they have not been repeated as the study's secondary objectives.

5. Limited data in this section directed us to do tagging without using any tagging software.

6. The findings are demonstrated in the next section of this paper.

7. It is noteworthy that due to the provider/provided nature of this agreement, now all studied library systems use its "provided" aspect which means it receives information but can not provide data for informational systems.

References

Alipour-Hafezi, M. (2009), "The Study of interoperability between informational systems of digital libraries in Iran and providing the suggested scheme", PhD thesis, Tehran Science and Research, Tehran.

Association of Research Libraries (ARL) (2005), "MINES for libraries, measuring the impact of networked electronic services", available at: www.minesforlibraries.org (accessed 10 November 2013).

Barton, J. (2004), "Measurement, management and the digital library", *Library Review*, Vol. 53 No. 3, pp. 138-141.

Bertot, J.C., Snead, J.T., Jaeger, P.T. and McClure, C.R. (2006), "Functionality, usability and accessibility: interactive user-centered evaluation strategies for digital libraries", *Performance Management and Metrics*, Vol. 7 No. 1, pp. 17-28.

Bishop, A.P. (1998), "Logins and bailouts: measuring access, use, and success in digital libraries", *Journal of Electronic Publishing*, Vol. 4 No. 2, available at: http://dx.doi.org/10.3998/3336451. 0004.207 (accessed 10 April 2013).

Bishop, A.P., Neumann, L.J., Star, S.L., Merkel, C., Ignacio, E. and Sandusky, R.J. (2000), "Digital libraries: situating use in changing information infrastructure", *Journal of the American Society for Information Science*, Vol. 51 No. 4, pp. 394-413.

Blandford, A., Buchanan, G. and Jones, M. (2004a), "Usability of digital libraries (editorial)", *Journal of Digital Libraries*, Vol. 4 No. 2, pp. 69-70.

Blandford, A., Keith, S., Connell, I. and Edwards, H. (2004b), "Analytical usability evaluation for digital libraries: a case study", in *Proceedings of the 2004 Joint ACM/IEEE Conference on Digital Libraries*, *Tucson, AZ*, 7-11 June, pp. 240-241.

Borgman, C.L. and Rasmussen, E. (2005), "Usability of digital libraries in a multicultural environment", in Theng, Y.L. and Foo, S. (Eds), *Design and Usability of Digital Libraries: Case Studies in the Asia Pacific*, Information Science Publishing, Hershey, PA, pp. 270-284.

Buckland, M. (1992), *Redesigning Library Services: A Manifesto*, American Library Association, Chicago, IL.

Chowdhury, S., Landoni, M. and Gibb, F. (2006), "Usability and impact of digital libraries: a review", *Online Information Review*, Vol. 30 No. 6, pp. 656-680.

Clomb, P., Rosch, H. and Preisig, A.V. (2012), "Libraries, e-lending and the future of public access to digital content", available at: www.ifla.org/publications/libraries-e-lending-and-the-future-of-public-access-to-digital-content (accessed 10 November 2013).

Dalrymple, P.W. and Zweizig, D.L. (1992), "Users' experiences of information retrieval systems: an exploration of the relationship between search experience and affective measures", *Library and Information Science Research*, Vol. 14 No. 2, pp. 167-181.

Fuhr, N., Hansen, P., Mabe, M., Micsik, A. and Solvberg, I. (2001), "Digital libraries: a generic classification and evaluation scheme", in Constantopoulos, P. and Solvberg, I. (Eds), *Proceedings of ECDL'01*, *Darmstadt*, pp. 187-199.

Fuhr, N., Tsakonas, G., Aalberg, T. and Agosti, M. (2007), "Evaluation of digital libraries", *International Journal of Digital Libraries*, Vol. 8 No. 1, pp. 21-38.

Garibay, C., Gutiérrez, H. and Figueroa, A. (2010), "Evaluation of a digital library by means of quality function deployment (QFD) and the Kano model", *The Journal of Academic Librarianship*, Vol. 36 No. 2, pp. 125-132.

Goh, D., Chua, A., Khoo, D., Khoo, E., Mak, E. and Ng, M. (2006), "A checklist for evaluating open source digital library software", *Online Information Review*, Vol. 30 No. 4, pp. 360-379.

Gonçalves, M.A., Fox, E.A., Watson, L.T. and Kipp, N.A. (2004), "Streams, structures, spaces, scenarios, societies (5s): a formal model for digital libraries", *ACM Transactions on Information Systems*, Vol. 22 No. 2, pp. 270-312.

Gonçalves, M.A., Moreira, B., Fox, E.A. and Watson, L.T. (2007), "What is a good digital library? – A quality model for digital libraries", *Information Processing and Management*, Vol. 43 No. 5, pp. 1416-1437.

Hassanzadeh, M. (2002), "Digital libraries: application, structure and librarians and future communicators", *Payam-e-Ketabkhaneh*, Vol. 12 Nos 3/4, pp. 42-48.

Isfandyari-Moghaddam, A. and Bayat, B. (2008), "Digital libraries in the future of research: assessment-centered surveys", *Quarterly of Library and Information*, Vol. 11 No. 3,

available at: www.aqlibrary.ir/index.php?module=TWArticles&file=index&func= view_pubarticles&did=755&pid=10 [in Persian] (accessed 1 September 2013).

Jose, A. (2007), "Evaluation of digital libraries: a case study", in Prasad, A. and Madalli, D.P. (Eds), *ICSD*, Indian Statistical Institute, Bangalore, pp. 229-238.

Kyrillidou, M. and Cook, C. (2008), "The evolution of measurement and evaluation of libraries: a perspective from the association of research libraries", *Library Trends*, Vol. 56 No. 4, pp. 888-909.

Kyrillidou, M., Cook, C. and Lincoln, Y. (2009), "Digital library service quality: what does it look like?", in Tsakonas, G. and Papatheodorou, C. (Eds), *Evaluation of Digital Libraries: An Insight into Useful Applications and Methods*, Chandos Publishing, Oxford.

Kyrillidou, M. and Giersch, S. (2005), "Developing the DigiQUAL protocol for digital library evaluation", in JCDL 05, Denver, CO, 7-11 June, available at: www.libqual,org/documents/admin/digiqual-jcdl05-V5.pdf (accessed 14 March 2013).

McClure, C.R. and Bertot, J.C. (2001), "Introduction", in McClure, C.R. and Bertot, J.C. (Eds), *Evaluating Networked Information Services: Techniques, Policy, and Issues*, Information Today, Medford, NJ, pp. 13-20.

Majidi, A., Zandian, F. and Hassanzadeh, M. (2010), "Users' expectation from the user interface screen of an academic digital library", *Journal of Information Sciences & Technology*, Vol. 25 No. 4, pp. 695-720.

Marchionini, G. (2000), "Evaluating digital libraries: a longitudinal and multifaceted view", *Library Trends*, Vol. 48 No. 49, pp. 304-333.

Noruzi, Y. (2011), "Analysis on user-friendly user link pages in Persian web pages at Iran digital libraries and providing suggested scheme", *Quarterly of IT*, Vol. 26 No. 3, pp. 655-674.

Noruzi, Y. and Alipour-Hafezi, M. (2001), "Digital libraries", *National Studies on Librarianship and Information Organization*, Vol. 12 No. 4, pp. 84-103.

Poll, R. (2001), "Performance indicators for the digital library", *Library Quarterly*, Vol. 11 No. 3, pp. 244-258.

Saracevic, T. (2000), "Digital library evaluation: toward evolution of concepts", *Library Trends*, Vol. 49 No. 2, pp. 350-369.

Saracevic, T. (2004), "Evaluation of digital libraries: an overview", available at: www.scils.rutgers.edu/~tefko/DLevaluationDelos.pdf (accessed 25 April 2013).

Saracevic, T. (2005), "How were digital libraries evaluated?", available at: www.scils.rutgers.edu/~tefko/DL_evaluation_LIDA.pdf (accessed 10 January 2013).

Saracevic, T. (2009), "Introduction: the framework for digital library evaluation", in Tsakonas, G. and Papatheodorou, C. (Eds), *Evaluation of Digital Libraries: An Insight Into Useful Applications and Methods*, Chandos Publishing, Oxford.

Saracevic, T. and Covi, L. (2000), "Challenges for digital library evaluation", in the Annual Meeting 2000 of the American Society for Information Science, available at: www.is.inf.uni-due.de/courses/dlss04/folien/saracevic00.pdf (accessed 10 November 2013).

Shiri, A. (2003), "Digital library research: current developments and trends", *Library Review*, Vol. 52 No. 5, pp. 198-202.

Snead, J.T., Berot, J.C., Jaeger, P.T. and McClure, C.R. (2005), "Developing multi-method, iterative, and user-centered evaluation strategies for digital libraries functionality, usability, and accessibility", available at: www.ii.fsu.edu/presentations/digilibasist2005.pdf (accessed 10 April 2013).

Van House, N.A., Butler, M.H., Ogle, V. and Schiff, L. (1996), "User-centered iterative design for digital libraries: the Cypress experience", *D-Lib Magazine*, Vol. 2 No. 3, available at: http://webdoc.sub.gwdg.de/edoc/aw/d-lib/dlib/february96/02vanhouse.html (accessed 10 April 2013).

Vullo, G. (2010), "A global approach to digital library evaluation", *Library Quarterly*, Vol. 20 No. 2, pp. 169-178.

Xie, H. (2006), "Evaluation of digital libraries: criteria and problems from users' perspectives", *Library & Information Science Research*, Vol. 28 No. 3, pp. 433-452.

Further reading

Bishop, A.P. (2001), "Logins and bailouts: measuring access, use, and success in digital libraries", *The Journal of Electronic Publishing*, Vol. 4 No. 2, available at: http://quod.lib.umich.edu/j/jep/3336451.0004.207?view=text;rgn=main (accessed 10 November 2013).

Nadi-Ravandi, S. and Haji-Zeinolabedini, M. (2009), "Indicators of design and assessment of digital libraries", *Health Management*, Vol. 12 No. 38, pp. 37-48.

Corresponding author
Mehdi Alipour-Hafezi can be contacted at: meh.hafezi@gmail.com

This article has been cited by:

1. Iris Xie, Krystyna K. MatusiakEvaluation of digital libraries 281-318. [CrossRef]