Academic Digital Library's Evaluation Criteria: User-Centered Approach

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Abstract—Academic digital libraries emerged as a result of advances in computing and information systems technologies, and had been introduced in universities and to public. As results, moving in parallel with current technology in learning and researching environment indeed offers myriad of advantages especially to students and academicians, as well as researchers. This is due to dramatic changes in learning environment through the use of digital library system which giving spectacular impact on these societies' way of performing their study/research. This paper presents a survey of current criteria for evaluating academic digital libraries' performance. The goal is to discuss criteria being applied so far for academic digital libraries evaluation in the context of user-centered design. Although this paper does not comprehensively take into account all previous researches in evaluating academic digital libraries but at least it can be a guide in understanding the evaluation criteria being widely applied.

Keywords—Academic digital libraries, evaluation criteria, performance, user-centered.

I. INTRODUCTION

DIGITAL infrastructure and repositories are widely created to support the activities of educational, workplace, and scientific communities, as well as virtual communities of interest that may center on topics as diverse as entertainment, crisis management, and health. Such work draws from fields that include computer-supported cooperative work and digital libraries [2]. Digital libraries are emerging as an important area of research and education for information science, computer science and a number of other related disciplines [50]. The term digital libraries existed since early of 1990's, but no conclusive definition exists due to the fact that different people seem to adopt them for their context of usage [20]

Digital library has emerged as a result of advances in computing and information systems technologies, and has been introduced in universities and to public. In order to remain a dynamic and important part of the university, academic librarians must embrace change and create digital libraries that offer innovative reference services [36]. Therefore, academic digital library is and should tie to the academic missions of the university. As being emphasized by Adida et al. [1], digital library brings the library to the user's desk, either at home or work, as long as they have personal computer and network connection. With such convenience to offer, these days academic digital libraries are seen as the most appropriate means to provide students, academicians and researchers with information they are seeking or searching for, just at their fingertips. Indeed, learning and information seeking environment has been dramatically changed through the use of digital libraries, in specific academic digital libraries. Students, academicians and researchers that located remotely and internationally can at all times access information resources offered by academic digital libraries. Limitations like distance, time consuming and authority especially to access to some refereed journals are no more bringing the burdens as academic digital libraries provide massive of access and features that ones cannot be sidelined in online learning environment.

However, one of big challenges to face by academic institutions is how to gauge the performance of their digital libraries systems in the context of users' perspectives? How far the academic digital libraries fulfill to users' needs? Are the systems useful to the users? Since academic digital libraries and other type of digital libraries as well are designed for people (its users) to use, evaluating the performance of the systems should prioritize criteria to reflect users' needs, satisfaction, desirability and so on. The remainder of this paper will discuss several criteria developed and applied by different authors in evaluating the performance of academic digital libraries, from the context of users-centered design where section 2 discusses on the academic digital libraries, followed by related works on digital libraries evaluation applied so far in section 3. Section 4 focuses on user-centered evaluation for digital libraries and section 5 discusses on criteria in evaluating academic digital libraries performance. Last section concludes this entire discussion.

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II. ACADEMIC DIGITAL LIBRARY

Learning environments are changing drastically especially when internet existed about two decades back. Moreover, acquiring knowledge and methods for education are becoming more sophisticated, faster, simpler and reliable when digital libraries introduced. Mishra [41] claimed that with respect to online learning environments, learning theories on how people acquire knowledge and methods for education can be classified into three groups: behaviorism, cognitivism - both for implications for education [40], and contructivism - for development and evaluation for online learning environments [26,27,41,45] as cited in Marshall et al. [40].

In present year, many higher institutions provide academic digital libraries. Kalinichenko et al. [30] noted that digital libraries may transform the way we learn, providing supporting resources and services, operating as decentralized but integrated/virtual learning environments that are adaptable to new technologies. In addition, they emphasized that digital library for education would facilitate innovation, but be stable, reliable, and permanent. Academic digital libraries are those libraries that serve the information needs of students and faculty of the college and universities [25]. The importance of academic libraries can be seen from the need of students using it a source of information to enhance their knowledge in desired field [54]. He emphasized that an academic digital library is the seat of knowledge in a university or college. By definition, academic digital library plays a very crucial role in bridging students, academicians and researchers' needs on information in this borderless information seeking era. Even though technology is seen as the main driver to paperless and digitized materials, add up with the rising cost of publication and service, the increasing demand of using academic digital library may be due to its spectacular impact on these societies' way of performing their study/research. Academic digital library may indeed support academic and intellectual endeavors towards the journey of not only simply for information seeking but also for exploring, researching and growing their knowledge via adapting the information systems and human-computer-interaction technologies.

III. RELATED WORKS

Research on the evaluation of digital libraries is in its infancy [42]. They claimed that researchers are still investigating the who, what, when, how and why of evaluation studies. They reported that early research focused on the technical aspects of building digital libraries, but now the emphasis has shifted to the design aspects of digital libraries so that users' needs can be satisfied. Goncalves et al. [22] admitted that digital library quality and evaluation is a very underrepresented research area in the digital library literature. They stressed that the first person to consider such problem is Saracevic [48] where he argued that any evaluation has to consider a number of issues such as the context of evaluation, the criteria, the measures/indicators, and the methodology. Since his analysis concluded that there are no clear agreements regarding the elements of criteria, measures/indicators, and methodologies for digital library evaluation, Fuhr et al. [19] proposed a descriptive scheme for digital libraries, which is based on four dimensions i.e. data/collection, system/technology, users, and usage. While Bertot et al. [3] concluded that functionality and accessibility as major digital library evaluation criteria, where it was based on their evaluation of Florida Electronic Library.

To gauge the performance of particular digital libraries, evaluative study is one of possible ways where the actual users of digital libraries' interest and concerns in using these information systems can be investigated and understood. Evaluation can play both a formative role, helping to continually refine and update goals, objectives, and services; and a summative role, helping to ascertain whether the goals and objectives are being met [46,52]. Hence, evaluating academic digital libraries is also crucial in meeting users' requirements of using digital libraries systems for academic purposes.

Digital libraries evaluation is a challenging task due to the complicated technology, rich content and a variety of users involved [7,49]. Borgman et al. [7] stressed that digital libraries are difficult to evaluate due to their richness, complexity, and variety of uses and users. The most recognized digital libraries evaluation criteria are derived from evaluation criteria for traditional libraries, information retrieval system performance, and human-computer interaction [12,37,48,49]. Using Alexandria Digital Library, Hill et al. [24] evaluated the system by collecting feedback about the users' interaction with this system's interfaces, the problems of the interfaces, the requirements of system functionality and the collection of the digital library. While Dillon [18] proposed a qualitative framework (termed TIME) for designers and implementers to evaluate usability of digital libraries which focuses on user task (T), information model (I), manipulation facilities (M) and the ergonomic variables (E). Marchionini [37] discussed a lists a number of approaches that can be used for evaluating digital libraries where for user-centered evaluation, it focused on the cognitive, interactive, and contextual aspects of information retrieval and considers users, use, situations, context, and interactions with the system.

Some of the evaluation studies extend to assess performance, content and services of digital libraries while service evaluation mainly concentrates on digital reference [10]. Other evaluation studies also look into the impact of digital libraries [37]. While usability studies conducted by Kassim and Kochtanek [32] on academic digital library was performed through the use of like focus groups, Web log analysis, database usage analysis, satisfaction surveys and remote usability testing; where the studies are their attempt to understand user needs, find problems and desired features, and to assess overall user satisfaction. Another angle of method in evaluating digital libraries was done by Borgman et al. [6] where they evaluated the Alexandria Digital Earth Prototype for use in undergraduate education, by using surveys,

interviews, and classroom observations.

IV. User-Centered Approach

Marchionini et al. [39] emphasized that people (users) and their information needs are central to all libraries, digital or otherwise. They added that all designing, implementing, and evaluating digital libraries must be rooted in the information needs, characteristics, and contexts of the people who will or may use those libraries. Critics by Dervin & Nilan's [17], as cited in Marchionini et al. [39], system-oriented approach was too narrow to actually identify user needs and required an approach that attempts to directly assess people's information needs. In addition to the needs of individuals and groups who make use of information in digital libraries, the needs of the providers and managers also influence design and evaluation. They claimed that evaluation of a digital library may serve many purposes ranging from understanding basic phenomena (e.g., human information-seeking behavior) to assessing the effectiveness of a specific design to insuring sufficient return on investment. Human-centered (user-centered) evaluation serves many stakeholders ranging from specific users and librarians to various groups to society in general.

Coleman & Sumner [15] were later agreed with Marchionini et al.'s [39] claim where they believed the objectives of a user-centered design process were to develop a deep understanding of user requirements for technology design and planning, and to get systematic user feedback on evolving library systems throughout the design process. In addition, they claimed that it was the responsibility of library designers to generate possible design options and to devise appropriate protocols and studies to elicit user feedback on these options.

Among two popular methodologies in collecting data for evaluating digital libraries via user-centered approach are surveys and observational studies, where the common techniques used are usability testing, focus groups, keystroke tracking, and user-questionnaires [45]. They pointed out that usually within digital library evaluation; surveys are used to address issues that relate to user-centered concerns where information derived from surveys can be used to inform decisions related to issues relevant to the digital libraries' users. They added that observational methods are ideal for providing information about the impact and uses of your digital library in real-life settings.

Digital libraries can be regarded as powerful tools if they are usable, useful and users benefit from using them. This shows that user-centered evaluation for digital libraries is imperative in understanding how well the system serve and fulfill its targeted users. Long [35] admitted that the common reason for evaluation was to identify users and their information needs. This includes knowing which resources users wanted most, what data format are mostly useful and other kinds of users' needs. In having worldwide digital libraries, the use of efficient digital information system is crucial in order to handle large number of concurrent users and text/data/files transactions. Furthermore there are different type of users using digital libraries (like students, academicians and researchers) with different level of computer skills/knowledge (like novice, intermediate or expert), and with different needs/purposes of using digital libraries. Users should be at the centre of any digital library evaluation and their characteristics, information needs and information behavior should be given priority when designing any usability study [16]. In Tsakonas et al. [53] study, their evaluation strategy for digital libraries was via analyzing the relationships between user-system, user-content, and content-system which headed to the following evaluation directions: usability (user-system), usefulness (user-content), and system performance (content-system).

Another interesting study was performed by Salampasis and Diamantaras [47]. They conducted an experimental user-centered evaluation of two hypermedia system architectures where each representing a different interaction model and information-seeking environment. The study was being experimented on two different types of digital libraries: a hypermedia digital library based on the World Wide Web and a digital library based on an agent-based Open Hypermedia System (OHS). Their results indicated that information seeking environments that support multiple seeking strategies through multiple interfaces may be more effective and efficient for some information seeking tasks. Their study also revealed that complex interaction models may not difficult to use even for inexperienced information seekers.

According to Goh et al. [21], one of the key functionalities of a digital library should be the matching of user work patterns. They emphasized to achieve this, a thorough understanding of the users of libraries and the system itself should be obtained. Apart from the need for deeper understanding of users, the fit between the tools used to craft the digital library and the necessary requirements has to be ascertained. Snead et al. [51] were earlier reported that it was possible to create a rich and robust evaluation methodology that can meet the needs of diverse user populations by combining functionality, usability, and accessibility. Likewise, for user-centered approach, evaluation criteria of the performance of digital libraries should take into account combination of evaluation designs and methods to collect as much data as possible.

Chowdhury et al. [14] implied that a well-designed digital library should have good usability features. While Blandford & Buchanan [5] extended usability to performance measures like efficiency of interactions, avoidance of user errors, and the ability of users to achieve their goals, affective aspects, and the search context. Bishop et al. [4] investigated the extent of use, use of the digital library compared to other systems, nature of use, viewing behavior, purpose and importance of use, and user satisfaction. Chowdhury and Chowdhury [12] stressed the need to assess the overall impact of digital libraries on users and society.

Mohd Razilan et al. [43] believed that many existing areas of research in digital libraries are being carried out to fulfill

the pace of demand in information retrieval, either in user-perspective or on system-perspective. Xie [55] was later agreed that although published research on digital libraries has increased, it mostly focused on technical issues and digital library use patterns. But the main issue being concerned by Xie [55] was that evaluating digital libraries need to consider few aspects like what the evaluation criteria are and how these criteria are being determined. He then argued that usability of a digital library primarily relates to its accessibility, i.e.:

1. How easily users can interact with the interface of the digital library,
2. How easily they can find useful information, how easily they can use the retrieved information, etc.
3. If information can be accessed easily then will digital library will be used frequently.

His study indicated that there exist similarities and differences in terms of digital libraries evaluation criteria proposed by users, researchers, and professionals. Among evaluation criteria applied in his study were such as:

1. Interface usability
2. Collection quality
3. Service quality
4. System performance

The findings showed that:

1. Users were more concerned with the availability of features but not the effectiveness of the features.
2. Users emphasized on accuracy and authority rather than completeness and currency of the collection.

Users' use of digital libraries, their perceived digital libraries evaluation criteria, and their preference, experience, and knowledge structure co-determine their evaluation of digital libraries.

Xie's [55] findings were somewhat agreed with findings revealed by Salampasis and Diamantaras [47] where through users tasks of seeking information, multiple interfaces may be more effective and efficient, and that is why users were more interested in what features available in digital libraries because they may have interest of exploring and rendering the interfaces and features of the systems. Developing effective user interfaces, suitable for meeting the varying needs of all the different types of users, is of paramount importance [13]. They suggested that user customization is important to suit with their specific needs.

V. EVALUATION CRITERIA FOR ACADEMIC DIGITAL LIBRARIES

Since academic digital libraries developed for their specific end users, user-centered evaluation is important towards understanding how useful and usable the systems to the students, academicians and researchers.

Previous researches on evaluating academic digital libraries had shown that in major, only usability studies had been carried out so far. Kassim and Kochtanek [32] performed usability studies of an educational digital library in order to understand user needs, find problems, identify desired features, and assess overall user satisfaction. Jeng [28,29], in her usability study on evaluating two academic library web

sites (Rutgers University Libraries Web site and the Queens College Web site) concluded that usability is a multidimensional construct. She further proposed an evaluation model for assessment of the usability of digital libraries by examining their effectiveness, efficiency, satisfaction, and learnability. User satisfaction covers ease of use, organization of information, labeling, visual appearance, content and error correction. The evaluation model was tested, and the results revealed that effectiveness, efficiency, and satisfaction are interrelated.

Kim and Kim [33] proposed evaluation framework in determining the important criteria for evaluating the digital institutional repositories in Korea. The framework composed of four categories: satisfaction, supportiveness, usefulness and effectiveness. The other component is utility, simply defined as whether the system can do what is needed.

Jeng [28] was earlier claimed that Karoulis and Pombortsis [31] suspect that usability (effectiveness, efficiency, and satisfaction) and learnability of educational environment are positively correlated but they never actually carried out a study to examine this possible correlation, nor did they provide operational criteria.

Another intriguing point which related to leaning theories is by taking into account the constructivism aspect. The constructivist model (constructivism focuses on the process by which people acquire knowledge) of learning emphasizes three main ideas [16], as cited in [40], which are important in a digital library context.

1. There is no single "correct" representation of knowledge,
2. People learn through active exploration, where exploration uncovers inconsistencies between experience and current understanding, and
3. Learning occurs in a social context.

Marshall et al. [40] referred to Kuhlthau's [34] statement where;

"*A basic principle for learning from digital libraries is to take charge of your own constructive process. In the digital library environment, it is important for students to actively seek to formulate a focused perspective that will guide their choices of what is pertinent and useful to them from the vast resources that may be generally relevant to the overall problem.*"

Kuhlthau [34] specified six steps of progress which can be supported by an effective digital library: initiation, selection, exploration, formulation, collection, and presentation. Some of these steps may be able to be considered as criteria in evaluating academic digital libraries as they are representing the requirements from students (as well as other users) in order to fully make use the process of accessing to the relevant resources in their learning environments. Selecting these criteria may not exhaustively portray the best method to evaluate an academic digital library but at least they can be considered as part of criteria that link between user-system and user-content aspects.

An evaluation on design process and implementation of The Alexandria Digital Earth Prototype (ADEPT) for digital learning for educational environment was conducted by Champheny et al. [11]. Their finding indicated that successful development of a functioning system appears to rely on the integration of the design and implementation processes through effective communication between designers and users. And this is what should be prioritized in determining the evaluation criteria for academic digital libraries as well.

VI. CONCLUSION

No doubt, academic digital library plays a very crucial role in bridging students, academicians and researchers' needs on information in this borderless information seeking era. Limitations like distance, time consuming and authority especially to access to some refereed journals are no more bringing the burdens as academic digital libraries provide massive of access and features that ones cannot be sidelined in online learning environment. It is worth to understand that digital libraries are not only offering online environment but more towards information resources, learning support and information literacy services which are accomplished through human-computer-interaction (HCI). Outcome from user-centered evaluation on academic digital libraries could be used in improving the systems' performance in future in accordance with users' requirements and desires on what sort of digital libraries suited to their needs.

Academic digital libraries are expected to become crucial tools for information seekers like students and academicians/researchers because they live with information and they need to grow their knowledge. To grow and enhance knowledge, they seek latest (or new), fast, reliable and accurate information where digital libraries systems should capable of providing these requirements for them. It is recommended that evaluation on digital libraries, particularly academic digital libraries, should take into consideration users' criteria and not merely from researchers' or librarians' own criteria. Users' point of views on what are the desired characteristics of academic digital libraries should be incorporated in the systems' features so that the digital libraries can serve as what they are expected to be. These will contribute to a holistic domain of user-centered evaluation criteria where academic digital libraries should and must be efficiently and effectively supporting academic or educational tasks. Many conclusions can be deduced from evaluation but the most crucial point is how the results from the evaluation can help developing effective and efficient digital libraries is somewhat remains to be seen.

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