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Usability study of the mobile library App: an example from Chongqing University

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Abstract

Purpose – The purpose of this paper is to determine the usability of the mobile library App of Chongqing University and to provide recommendations for improving the experience of App users.

Design/methodology/approach – Usability testing, which comprised pre-test questionnaires, accomplishing tasks, and post-test surveys, was conducted in this study. The effectiveness and efficiency of the App, as well as user satisfaction with it, were measured.

Findings – The mobile App was proven effective but the efficiency of the App required improvement. With regard to user satisfaction, the factors "clarity" and "usefulness" received the lowest and highest scores, respectively. The descriptions of mobile services were unclear and confused users; nonetheless, the services provided by this App were appealing and useful to the users. Based on the measured user experience, this study proposed several recommendations for enhancing the usability of the App.

Originality/value – An increasing number of domestic and foreign libraries have begun to use mobile Apps to provide new services to patrons. In the future, smartphones are likely to become crucial to the delivery of information services. Given the extensive use of the Super Star Mobile Library system adopted by Chongqing University Library in China, the usability of such a system must be investigated. Improving the usability of the mobile library App can help enhance user experience.

Keywords Evaluation, Academic libraries, Usability, Mobile App, Mobile library, Mobile service

Paper type Research paper

1. Introduction

The popularization of third-generation communication technology, the development of mobile internet, and the declining prices of smartphones have established a solid foundation for the use of mobile phones to browse the internet. As a result, the number of mobile phone users has increased worldwide. IDC (2014) revealed that vendors shipped 1,004.2 million units of smartphones internationally. Moreover, vendors shipped more than 1 billion units for the first time in 2013; this value was 38.4 percent higher than that obtained in the previous year. The same trend was observed in the sales of Chinese smartphones. The Ministry of Industry and Information Technology (2014) reported that 423 million smartphones were shipped in 2013; this figure was 64.1 percent higher than that listed in the previous year. The number of Chinese cell phone users also increases continuously. In July 2014, the China Internet Network Information Center (2014) published the 34th China Internet Network Development Statistical Reports and revealed that 527 million units of Chinese cell phones were

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produced as of June 2014. The annual growth rate was 13.6 percent. Moreover, the proportion of cell phone users among cyber citizens increased from 81.0 in 2013 to 83.4 percent in 2014. These users outnumbered traditional personal computer (PC) cyber users. College students play essential roles among cyber citizens, and a large proportion of these students use smartphones. Zheng *et al.* (2014) revealed that 86 percent of college students in China were smartphone owners, and only 2 percent of these students owned ordinary cell phones without internet browsing features.

To satisfy the demands of patrons who access library services via smartphones and other handheld terminals, the libraries of several universities across China, including the Beijing Institute of Technology, South China University of Technology, Chongqing University, and Peking University, have begun to provide mobile services (Wei *et al.*, 2013). The service modes of mobile libraries include SMS, WAP, and APP; the latter two are the main modes employed in Chinese libraries, whereas APP is the main mode used in western libraries (Wei *et al.*, 2014). Mobile services in Chinese universities have developed rapidly over recent years; as of September 2011, 14 of the 39 Chinese universities (35.9 percent) that belong to the 985 Project (Wikipedia, 2014a, b) provide mobile library services (Li, 2013). According the researchers' investigation conducted in August 2014, the number of such libraries has increased to 36 (92.3 percent) since then. Furthermore, 27 of these libraries have adopted the Super Star Mobile Library product (Baidu Encyclopedia, 2014).

In September 2013, Chongqing University Library launched its own mobile library service by adopting a customized product from the Super Star Mobile Library (Baidu Encyclopedia, 2014). The university library aimed to satisfy the demands of patrons who wished to access mobile library services via smart terminals. Patrons can access mobile library services by either visiting a WAP web site or installing an App in their IOS or Android devices. The mobile services provided by the mobile library App are mobile OPAC, e-books, digital resource retrieval, digital resource reading, announcements, personal library (borrowed items and book renewal), ISBN barcode scanning, book reviewing, resource sharing, digital document delivery, and resource subscription. Most of the mobile services are similar to the services of the desktop library web site, except barcode scanning, resource sharing, and resource subscription. These library services can only be accessed by authenticated users, and the username and password used for the mobile library are similar to those of the desktop library web site. Users are authorized through the web service interface. In addition to diverse mobile services, rich resources are also a feature of the mobile library. Patrons can read more than 1 million volumes of e-books (30,000 volumes of which are in EPUB format), browse more than 300 types of newspapers, watch 18,400 sets of videos, listen to 11,034 sets of audio materials, and access 660 sets of open courses. The users of this App can also obtain digital resources from 78,000,000 journal articles, 154,780,000 foreign-language journal articles, and 3,860,000 pieces of dissertation metadata.

Patrons prefer the mobile library App to the WAP site because of the continuous popularization of smartphones and the enhanced functions of mobile applications. Therefore, this research focusses on the mobile library App for Chongqing University Library (shown in Plate 1). Since its inception, this App has been downloaded and installed 450 times per month on average and has received many excellent reviews from patrons. However, this App still encounters several problems. Therefore, the Technology Department of the library aimed to upgrade the App. In the current study, researchers intend to determine whether or not the mobile App can be operated stably on different terminals. Usability studies have been recognized as fundamental in

Plate 1.
Homepage of the mobile library App

evaluating products and systems (Griggs *et al.*, 2009); at present, however, few usability tests have been developed for the mobile library App. Thus, such tests must be conducted among patrons to obtain reviews and suggestions for improvement from patrons, as well as to understand how users feel when they visit mobile libraries through different devices and platforms. In line with this need, a usability study is performed on the mobile library App of Chongqing University Library to measure effectiveness, efficiency, and user satisfaction.

2. Literature review

2.1 Usability

Usability was introduced in the late 1980s (Butler, 1996) and is extensively used in evaluating the performance and acceptance of products and systems (Wichansky, 2000). Although usability studies may not be the most efficient technique for site evaluation, they provide reliable quantitative estimates of performance and of subjective user satisfaction (Wichansky, 2000). Usability attributes help assess the user-friendliness and quality of a certain product; in fact, existing usability studies on mobile applications (Zhang and Adipat, 2005) have identified nine generic usability attributes: learnability, efficiency, memorability, errors, user satisfaction, effectiveness, simplicity, comprehensibility, and learning performance. From among these attributes, the current

usability study aims to measure three, namely, effectiveness, efficiency, and user satisfaction, in relation to the Chongqing University Library mobile App. These three attributes are often adopted to test the usability of mobile library services (Yeh and Fontenelle, 2012; Pendell and Bowman, 2012; Tsiaousis and Giaglis, 2014) and mobile devices (Coursaris and Kim, 2006). Effectiveness refers to the completeness and accuracy with which specified users achieve certain goals. Efficiency refers to how quickly and efficiently users can accomplish a task or the resources expended in relation to the accuracy and completeness with which users achieve goals (Wallace *et al.*, 2013). User satisfaction reflects the attitude of users toward the use of mobile Apps.

2.2 Usability testing

Usability studies typically utilize small samples. A total of 85 percent of usability problems were detected by five users, particularly when these users were homogeneous (Nielsen and Landauer, 1993). Given the variety of mobile devices and platforms, however, large numbers of participants have been recruited to investigate the usability of mobile applications in recent studies. For example, 12 students were asked to test the usability of a mobile library web site (Pendell and Bowman, 2012), another 12 individuals volunteered to determine the usability of another similar web site (Yeh and Fontenelle, 2012), and ten participants were recruited to test the redesigned mobile web site of a health sciences library (Rosario *et al.*, 2012).

Two major methodologies, namely, field studies and laboratory experiments, are applied to measure the usability of mobile applications (Zhang and Adipat, 2005). Field studies are preferred over laboratory experiments because they preserve the real and mobile environment in which tasks are normally accomplished. Thus, the user experience obtained in a real environment is more reliable and realistic than that obtained under laboratory settings. However, literature has reported three fundamental difficulties in conducting field studies (Kjeldskov and Stage, 2004). It was complicated to establish realistic studies, far from trivial to apply established evaluation techniques, and difficult to collect data. Laboratory experiments also have several advantages over field studies, including full control over tests, easy measurement of usability attributes, and the capability to use video in capturing user behavior (Zhang and Adipat, 2005). Billi *et al.* (2010) did not determine a consensus in previous literature with regard to the significance or usefulness of the differences in the laboratory and field testing of mobile applications. However, Hegarty and Wusteman (2011) indicated that field studies were more suitable for testing the usability of mobile applications. Ma *et al.* (2013) argued that traditional laboratory experiments are often tedious, expensive, and cannot reflect real use. Wisniewski (2011) reported that, although laboratory testing can be useful, such experiments cannot evaluate the behaviors of people in real-life situations. Therefore, real mobile devices should be used whenever possible (Zhang and Adipat, 2005). Determining the actual experience and behavior of users in a real environment is important because such experiences contribute to improving mobile library services. Therefore, a field study is conducted for the current research. All user operation processes are recorded for further analysis.

2.3 Usability of the mobile library service

We currently live in the age of mobile technology, and many people own smartphones that are often used in surfing the internet. An increasing number of libraries have also begun to provide mobile services through mobile applications. Patrons can access

various library services through their mobile devices, including mobile OPAC, library guides, personal library, library news, and digital resource retrieval (Kroski, 2008; Wei *et al.*, 2014). However, the efficiency of and user satisfaction with these mobile library services remain unclear. Although usability tests have been conducted extensively in digital libraries (Rogers and Preston, 2009), usability studies on mobile library services remain limited. At present, the questionnaire survey method is mainly adopted to determine the feelings of patrons toward the use of mobile libraries, as well as user satisfaction levels (Aharony, 2013; Karim *et al.*, 2006; Ivana, 2014). However, the real experience of users is difficult to determine.

Mobile sites and applications are the main service modes of mobile libraries. Previous studies focussed mainly on the usability of mobile library sites; usability studies have been conducted on such sites for redesign and optimization purposes (Rosario *et al.*, 2012; Pendell and Bowman, 2012; Yeh and Fontenelle, 2012; Wang and Zhang, 2013). Rosario *et al.* (2012) evaluated the effectiveness and efficiency of the mobile site for the Health Sciences Library, but user satisfaction was not measured. In this study, comments on and recommendations for site design were made by the participants. Pendell and Bowman (2012) evaluated the usability of the mobile web site of the library at Portland State University by applying a hybrid field and laboratory methodology. Consequently, menu and navigation changes were made and new menu options were created. Yeh and Fontenelle (2012) compared user experiences with library web sites that are optimized for mobile devices against experiences with HTML-based web sites that are not optimized for mobile devices. The study results indicated that patrons were more satisfied with the site optimized for the mobile environment. Wang and Zhang (2013) adopted the questionnaire method to collect data on user experience when visiting the mobile library of Tsinghua University; these researchers also proposed usability design principles for the mobile library web site. However, user tasks were not designed in this study, and usability attributes were not measured. Document databases can also be searched via smartphones. The usability of EBSCOhost Mobile, which is the mobile version of EBSCOhost, was tested and recommendations proposed for changing the interface and navigation to enhance usability (Hegarty and Wusteman, 2011).

Examples of mobile library App usage are few; in fact, only two usability tests have been conducted on a mobile library App. The usability of Boopsie (Johnstone, 2011) from the University of Wisconsin – Eau Claire was evaluated as a mobile library App (Miller *et al.*, 2013); in this study, participants were asked to complete certain tasks using an iPad 2. However, different devices and platforms were not considered. The study results revealed that a simple mobile application interface has several advantages over that of a conventional library web site. Chen (2013) tested the usability of the Shanghai Mobile Library; however, this researcher measured only user satisfaction. Detailed suggestions were presented for improving the usability of the mobile library, such as highlighting interaction design and enhancing the usability of the user interface.

The Super Star Mobile Library adopted by Chongqing University Library is the most well-known mobile library product in China. However, no research has been conducted on the usability of this mobile library system, despite its extensive use across all libraries in this country (Wei *et al.*, 2013). Usability research helps enhance user experience on mobile library Apps, and the methodology and evaluation results serve as valuable references to improve user experience for other libraries that adopt the Super Star Mobile Library.

3. Methodology

A large number of participants are required to test the usability of mobile applications. Thus, the researchers determined to recruit 12 patrons who use the mobile library App on their personal mobile devices; these patrons include two teachers, five undergraduate students, and five graduate students of Chongqing University. All participants met the following criteria: owned a smartphone through which the mobile App can be downloaded and installed; and were familiar with the desktop version of the library web site. The participants were recruited through an announcement posted on the library homepage and on the formal Bulletin Board System of the university. These announcements described the requirement and purpose of the test and offered prepaid phone cards worth 50 RMB as incentives for participation.

A field study was conducted to test the usability of the mobile App and to analyze the experience and behavior of users in an actual environment. All participants used their own smartphones during the test, and a controlled environment was established to prevent disturbances. A meeting room in the library served as the test spot because of its comfortable and quiet environment. A camera with video recording capacity captured the screens of the devices, the actions of the participants, and the voices of the participants and of the interviewer. To secure the privacy of the participants, the mobile phone screens of their devices, hand movements, and audio were recorded throughout the course of the session.

The usability tests were conducted in the winter of 2014. The tests comprised the following parts:

(1) Preparation stage: prior to testing, the researchers read a scripted introduction and orientation explaining the purpose and methodology of usability testing. The researchers clarified to the participants that the purpose of the study was not to evaluate their skills, but rather to assess the usability of the mobile App. The participants were encouraged to express their comments on the mobile App during the test. The functions and user authentication procedure of the App were also introduced to the participants, but operation examples were not provided. Then, the testing process and matters of concern were described. Finally, the participants were instructed to download and install the mobile library App.

(2) Pre-test questionnaire: the pre-test questionnaire was designed to determine the experience of participants in using the mobile library service and to obtain information regarding their cell phones. The participants were asked to complete a questionnaire that included the following questions:

- What is your phone model and operating system?
- Do you know that Chongqing University offers mobile library services?
- Have you ever used the mobile library service of Chongqing University Library?
- Have you ever searched for academic information through smartphones?
- Have you ever searched the library collection through smartphones?
- Have you ever read e-books through smartphones?

(3) Accomplishing tasks: ten tasks were designed based on the functions and services of the mobile library App to cover the majority of services.

The participants completed these tasks as scheduled with their own phones, and each task was to be accomplished within three minutes. The use of WIFI was not permitted during the test. No assistance was provided for task completion unless an error occurred. Two assistants were present for all sessions; one served as the note-taker and timekeeper while the other was the cameraman. In all tests, participants were encouraged to express exactly what they were thinking as they attempted the task at hand. After completing each task, the researchers interviewed the users to determine the problems encountered and to obtain their comments and recommendations regarding the accomplishment of each task. The completion time of each task was also recorded, and the entire operation was captured on camera. The ten tasks performed are described as follows:

- Task 1: one specific book should be located and its catalog number recorded.
- Task 2: the ISBN code of one book should be scanned to determine whether or not the library contains such a book. If the book is available, then its catalog number should be recorded.
- Task 3: the patrons should locate the items they borrowed and complete the renewal process for one book.
- Task 4: one electronic newspaper should be located and the front page headlines listed.
- Task 5: patrons should subscribe to one sports program.
- Task 6: one journal article should be retrieved and sent to the patrons' personal mailboxes. The selected article should then be placed under favorites.
- Task 7: one video should be located and placed under favorites.
- Task 8: one e-book should be searched and downloaded.
- Task 9: requests should be made for library notices and announcements.
- Task 10: one electronic dissertation should be located.

(4) Post-test survey: upon accomplishing the ten tasks, the participants immediately evaluated their satisfaction with the task on a Likert-type scale.

Effectiveness, efficiency, and user satisfaction were measured in the test. Effectiveness was evaluated as the success or failure to complete the task; efficiency was measured as the time spent on performing the task; and user satisfaction was assessed through a satisfaction score. Upon accomplishing the ten tasks, the participants were required to fill out a Likert scale immediately. The scale included the following factors: accessibility ("Can you locate the required information easily?"), clarity ("Are the function identifications of the App clearly described?"), ease of use ("Are the functions and services of the App easy to use and master?"), efficiency ("Is the system efficient during use?"), usefulness ("Are the functions and services of the App useful for learning and research in your opinion? Does the App appeal to you?"), and satisfaction ("Are you satisfied with the App?"). The participants scored the five factors from one to seven based on their experiences. The three measured attributes were coupled with the notes taken while the participants accomplished the tasks, and the comments and recommendations of the participants regarding potential changes to the mobile App were obtained.

4. Results

4.1 Pre-test questionnaire results

The distribution of the 12 participants, as well as their phone models, is shown in Table I. Five of the 12 participants used phones operating with the IOS system, whereas seven owned phones operating under the Android system. One patron used a Windows phone during the recruitment process; however, this individual did not participate in usability testing because the mobile App was not available on the Windows phone platform.

Seven out of the 12 participants were aware of the mobile App provided by the library. However, only one of the seven participants had used this App, thus indicating the low awareness of the participants regarding the mobile library among the participants and the need to publicize this service further. Four of the 12 participants had used their smartphones previously to search for academic information and to retrieve information via OPAC. In total, 11 participants read e-books using their phones. Therefore, the patrons reported a high recognition of mobile reading.

4.2 Effectiveness and efficiency test results

Table II shows that four tasks (tasks 3, 4, 5, and 7) were completed by all participants, two tasks (tasks 1 and 10) were completed by 11 participants, and the remaining four tasks were finished by less than 80 percent of the participants. The proportion of completed tasks was 79.2 percent (95 out of 120).

Tasks 2, 6, 8, and 9 were completed by a small proportion of participants. Scanning is an important function installed in smart App programs, and most users could understand and master the function. However, eight participants did not complete task 2 (ISBN scanning

Number of participants	Operating system	Phone model
7	Android	Xiaomi 2S; Xiaomi 2A; Hisense X68T; Samsung I9002; Samsung N719; OPPO 813T; Cooplad 5216D
5	IOS	IPhone 4S*3; IPhone 5S; IPhone 5

Table I. Distribution of participants based on phone operating system and model

Task no.	Number of participants completing the task	Proportion of tasks completed (%)	Longest completion time (seconds)	Shortest completion time (seconds)	Average completion time (seconds)	Mean deviations	SD
1	11	91.67	165	23	71.36	43.85	50.43
2	4	33.33	50	22	35	8	10.04
3	12	100	84	11	37.1	16.27	20.43
4	12	100	65	22	47.17	10.31	12.75
5	12	100	124	12	35.42	18.65	29.30
6	9	75	139	60	101.44	20.84	23.87
7	12	100	96	29	53.3	17.25	20.78
8	7	58.33	166	55	101.9	39.27	42.14
9	5	41.67	74	18	53	16.4	20.50
10	11	91.67	147	26	60.55	27.34	35.63

Notes: Average completion time refers to the mean value of time spent on completing tasks by the participants who did so successfully; when task completion time exceeded three minutes, the participant failed to finish the task

Table II. Task completion during the usability test

function) in this study. On the basis of video analysis and notes, this low completion rate can be attributed to the inconspicuous identification of functions, which prevented most participants from accessing the scanning function. Tasks 6 (searching for journal articles) and 9 (checking notices) were not completed because the label of the function module was vague and hindered the users from accessing the function. Five participants failed to complete task 8 (searching for e-books) because they were confused and could not access the e-books through the several probable entry points. Therefore, the failure to locate the exact entry points of functions and services is considered the main reason behind the low proportion of completed tasks. This result indicates that easy-to-locate function modules and labels that identify functions precisely are crucial to system effectiveness.

When successfully completed tasks alone were considered, the average task completion time of the participants was 58.5 seconds. This result differed significantly from that of librarians. Given the same test, the average task completion time of a librarian who was familiar with the mobile service was 20.3 seconds. Therefore, the efficiency of the mobile App must be promoted further. Tasks 2, 3, and 5 were completed in less than 40 seconds on average and indicated high efficiency. Tasks 1, 6, 8, and 10 were completed in more than 60 seconds on average, thus suggesting low efficiency.

Task 1 (searching the library collection) is a simple task and involves a commonly used service for desktop web site patrons. However, the average completion time for this task was 71.4 seconds. Upon viewing the recorded video, the researchers determined that three participants in particular took a long time to complete the task: one inputted the wrong retrieval words and generated incorrect results, whereas the other two consumed much time locating the entry point to the retrieval function. Therefore, the most frequently used services should be located in the foremost and most prominent side to help users locate the entry point quickly.

Task 6 (searching for journal articles) is another commonly used service, and the task can be completed by entering the "academic resources" module. Nonetheless, the completion time of the participants reached 101.4 seconds on average. Although the "academic resources" module (shown in Plate 1) was located on the homepage, the participants spent much time locating the entry point. After the entrance of "academic resources" modules (shown in Figure 1), the first step in retrieving academic resources involves selecting the document type (books, journals, newspapers, videos, and dissertations) of the desired resources. However, most participants failed to notice the alternative option given its inconspicuous position below the "Search For" box. Although journal articles were retrieved most frequently, "Book" was the default document type of the system rather than "journal articles;" as a result, most participants failed to retrieve the required articles. Tasks 10 (searching for dissertations) and 6 (searching for journal articles) were located in the same "academic resources" module but were categorized under different resource types. Readers encountered almost similar problems, which resulted in confusion.

Task 8 (searching for e-books) is among the favorite mobile services of patrons; nonetheless, the task took long time to complete. The entry points to e-book access were disordered and hindered the participants from accessing the service. These users could not choose from among "Book World," "Bookshelf," and "Academic Resources" (shown in Plate 1) and could not identify the entry point to e-book retrieval quickly.

4.3 Satisfaction test results

Integers from 1 to 7 were applied to the evaluation factors by the patrons. Number 1 was "not at all satisfactory," whereas number 7 was "completely satisfactory." A high

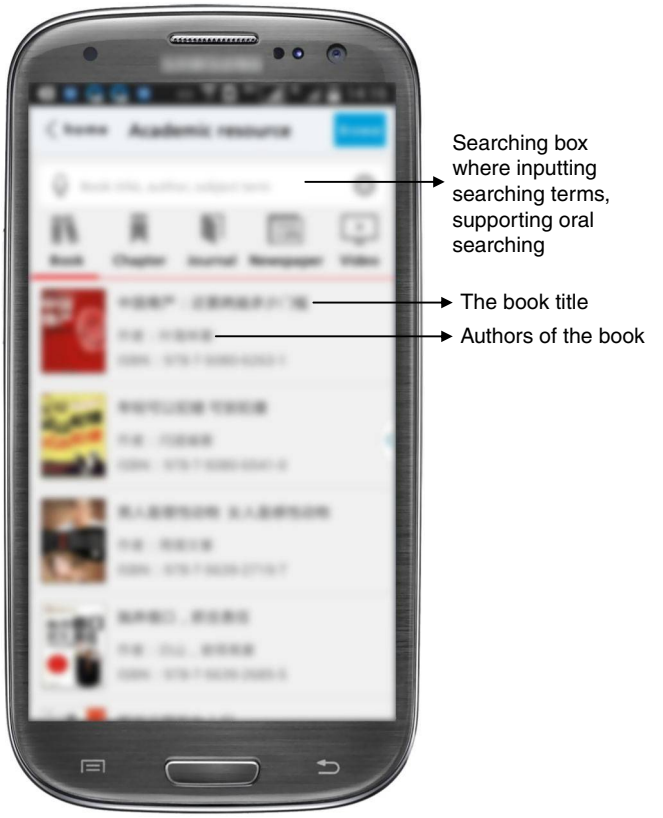

Figure 1. "Academic resources" module of the mobile library App

score indicated that users were highly satisfied with respect to the evaluation factors. The average evaluation scores of the targets are displayed in Figure 2. Questionnaire reliability refers to the degree of consistency or stability of questionnaire results, and a Cronbach's α value of more than 0.7 indicates high reliability (Wikipedia, 2014a, b). As per SPSS, the Cronbach's α value of the satisfaction survey used in this study was 0.856, thereby signifying that the survey was highly reliable and stable.

Figure 2 indicates that the participants scored the "clarity" factor the lowest (4.67) among the five factors. This finding suggests that function identification and label description are unclear; thus, users were confused and misunderstood the services. This result was almost consistent with the analysis results for "effectiveness," as mentioned previously. "Usefulness" attained the highest score, which indicates that the participants were satisfied with the abundance of useful mobile services provided by the mobile App. Furthermore, the participants considered such services to be helpful to scientific research and to the learning process. The service functions of the mobile App also appealed to the patrons.

4.4 Evaluation of usability attributes

Three metrics are adopted to measure usability, namely, effectiveness, efficiency, and satisfaction. The mobile App exhibits favorable effectiveness given that 79.2 percent of

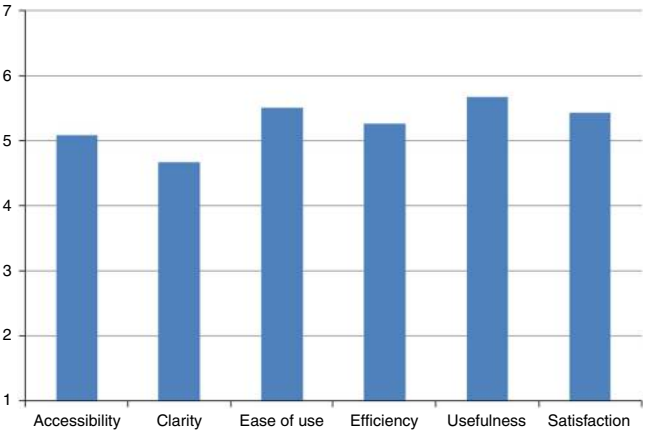

Figure 2. Statistical table for the participants satisfaction survey

Notes: 1, not at all satisfactory; 2, very dissatisfactory; 3, dissatisfactory; 4, basically satisfactory; 5, satisfactory; 6, very satisfactory; 7, completely satisfactory

the tasks were completed. However, the efficiency of the mobile App should be promoted further because the tasks were completed in 58.5 seconds on average. The satisfaction level of the participants with the mobile App was given an average score of 5.25, thus indicating that the participants were very satisfied with the mobile service and functions. Moreover, the obtained suggestions for improvement can help enhance the usability of the mobile App.

Learning performance is another important attribute of usability studies. Approximately 79.2 percent of the tasks were completed by the participants, 92 percent of whom were using the mobile library service for the first time. The participants learned how to use the App quickly; therefore, the mobile library App has a favorable learning indicator.

5. Discussions and recommendations

5.1 Adjustment of the location and identification label of the functional module

Based on the test results mentioned previously, the participants were unsatisfied with the "clarity" factor of the mobile App. A reason for the low effectiveness and efficiency in the accomplishment of several tasks was the failure to quickly locate the entry point of the function module. As such, the homepage should be redesigned to improve the usability of the mobile library App, and the location of the function should be adjusted. In addition, the identification label for the functional module should be accurate and easy to understand.

The function modules on the homepage cannot be located easily because smartphones screens are small. Thus, commonly used functions and services must be placed on the homepage to assist users in searching for information and in using the applications. The label for the function module must be standardized to limit distraction to the users. For instance, "collection searching" should be modified to "finding books;" "scanning" should be modified to "scanning ISBN;" "academic resources" should be modified to "academic articles;" and "book world" should be modified to "e-books." The modified homepage design is depicted in Plate 2. Library

Plate 2. Modified App homepage design

notices must also be separated from system messages to reduce confusion among users. Furthermore, all modules must be described by icons and words for easy understanding. For instance, "My library" serves as the personal center for patrons to store personalized contents, including borrowing records, favorites, bookshelves, and personal subscriptions.

Subjecting the mobile App to usability testing provided the team with valuable information and led to the implementation of important changes to the subsequent version of the App. Several recommendations are considered for this update; for instance, a participant suggested adding the functions of "reserving a computer" and "reserving a study room," which are well-known services to patrons of the desktop web site.

5.2 Optimization of search functions and promotion of searching efficiency

The efficiency test results indicated that the efficiency of the mobile App was low. The capability to quickly search for and locate the document needed was the primary factor affecting this attribute. Therefore, searching functions should be optimized and searching efficiency promoted to improve the efficiency of the mobile App.

Inputting retrieval words and retrieving information through smartphones can be difficult because of the small screens of such devices. Hence, enhancing the retrieval function of mobile applications is crucial to promoting user experience. In the usability

test conducted in this study, the participants complained about the retrieval function of the system given that large numbers of records are difficult to display on small mobile device screens. The addition of an advanced search function can narrow search scope effectively while improving search efficiency. OPAC offers only a simple search function; therefore, the aforementioned addition is necessary. The "videos" module also lacked a search function; users can select videos only by browsing. Therefore, such a function must be added to this module. In addition, "Academic articles" (formerly "Academic resources") must include various document types, such as journal articles, conference articles, and dissertations. In this module, "journal articles" should be set as the default option for its most frequent use. Furthermore, the "book" document type should be removed from the "academic articles" module and added to the "e-book" module. Finally, advanced search and sort functions must be integrated to arrange results based on time and relevance; this sorting function can assist users in locating and selecting documents.

5.3 Offer human-oriented and user-friendly operations based on smartphone characteristics

According to the recorded videos, some operations are not human-oriented and user-friendly. That is one of the reasons why participants were not satisfactory with the App. The success of system operations, such as subscription, placing the paper and video under favorites, is not indicated to users. Therefore, users are unable to determine whether or not an operation is successful, and they are confused as a result. In the subsequent updates to this function, information regarding operation will be provided to promote interaction between the system and the users.

Given that the mobile library system is a man-machine interactive system that provides services through mobile terminal devices, users can access the library through their mobile devices. The organization and display of information are important considering several attributes, such as small screens and the low input efficiency associated with mobile devices. Operation times must also be minimized because cell phone operation is not as convenient as PC operation. So after scanning ISBN of a book, the library collection must be displayed directly rather than only providing a display of detailed information of the books. Inputting words via cell phones is also inconvenient, and the system must provide inputting reminders to lighten the load on users. Document delivery through e-mail and the requirement to input security codes is troublesome as well; such codes are suitable for PCs as a safety measure, but these codes are unsuitable for cell phones because the input process is challenging. Thus, participants suggested eliminating the need for security codes. Furthermore, contents, such as borrowing records, must be displayed properly given the limited screen size of cell phones. If many records exist, then the book catalogs can be displayed in tabular form to save space.

6. Conclusions

The provision of library services via mobile devices is expected to increase rapidly in importance in the coming years. Smartphones are increasingly common, and libraries have begun to develop their own mobile services to reflect this development. Usability tests not only examine the effectiveness, efficiency, and user satisfaction of mobile applications but also help obtain numerous suggestions for improvement based on user

experiences. These results contribute significantly to the improvement and promotion of such Apps. Moreover, promoting the usability of the studied mobile App will also help encourage individuals to use the library service and enhance the quality of such service significantly.

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