Identifying Requirements and Quality Attributes from the point of View of Users of Mobile Digital Libraries

José Meireles[1][0000−0001−5780−813X], Kennedy Nunes[2][0000−0003−0826−8207],
Arthur Passos[2][0000−0002−2823−3645], João Santos[2][0000−0001−8957−1915],
Yandson Costa[2,3][0000−0001−8219−6462], José Durand[2][0000−0002−3189−8285],
Rayanne Silveira[1,2][0000−0001−5205−9328],
Alana Oliveira[1,2,4][0000−0001−7870−3943], Davi Viana[1,2,3,4][0000−0003−0470−549X],
Ana Emilia Figueiredo de Oliveira[2][0000−0003−4371−4815],
Mario Teixeira[2,3,4][0000−0001−8771−1478], and
Luis Rivero[2,3,4][0000−0001−6008−6537]

[1] Computer Engineering Department - ECP, Federal University of Maranhão
(UFMA), Sao Luis, Brazil
{jose.victor}@discente.ufma.br
[2] Directorate of Technologies in Education - DTED/UNA-SUS, Federal University of
Maranhão (UFMA), Sao Luis, Brazil
{kennedy.anderson, arthur.passos, joao.davi, yandson.jesus,
durand.jose}@discente.ufma.br, {rayanne.silveira, alana.oliveira,
davi.viana, ana.figueiredo, mario.meireles, luis.rivero}@ufma.br
[3] MSc Program in Computer Science - PPGCC, Federal University of Maranhão
(UFMA), Sao Luis, Brazil
[4] PhD Program in Computer Science – DCCMAPI, Federal University of Maranhão
(UFMA), Sao Luis, Brazil

Abstract. Due to the COVID-19 pandemic there has been a significant growth in the adoption of online educational resources, including mobile digital libraries. Thus, several quality attributes have been indicated by both industry and academy for designing useful and usable digital libraries. Nonetheless, we are not aware of a complete list of requirements that could be met to develop high quality digital libraries in the mobile context. In this paper, we try to meet this gap by identifying features that digital libraries should provide. To do so, we carried out an analysis of 20 Brazilian mobile digital libraries in the market, identifying requirements that provide functionalities for users. Also, we analyzed app comments from the top rated and least rated mobile digital libraries apps, to extract quality attributes. In all, we identified 14 requirements through the analysis of the applications and 49 quality attributes considering the opinions on users' comments. The list of requirements and quality attributes is useful to understand the users' expectations and understand what to maintain or remove when designing and developing a mobile digital library.

Keywords: Mobile Digital Libraries, Feature Analysis, App Comments Analysis, Software Requirements, Quality Attributes

1   Introduction

Mobile digital libraries belong to a category of mobile applications that has great potential to improve student and researcher access to academic resources [9]. The number of interventions from the use of digital libraries to stimulate learning has increased, as their use can improve the students' and researchers' image by providing a better match with the technologies that younger people are naturally adopting [1]. However, despite the increase interest in this type of applications, users still have difficulty using them [11].

In the past few years, there has been a significant growth in the adoption of online educational resources, including mobile digital libraries [4]. As a result, the interest on the definition of requirements necessary for digital libraries from the point of view of users has increased [17,16]. Nonetheless, we are not aware of a complete list of requirements that could be met to develop high quality digital libraries in the mobile context. Consequently, there is a need to support software development teams in the definition of requirements that they will include during the design of a mobile digital library or during their validation. It is important to define requirements properly, as poorly performed requirements engineering can lead to the development of low quality software and not meeting the users' expectations [5].

In this paper, we try to meet this gap by identifying features that digital libraries should provide to be complete and deliver functionality, while also analyzing the main complains users have when using these features. To do so, first, we carried out an analysis of 20 Brazilian mobile digital libraries available in the Google Play store. Then, considering a subset of these apps that had the highest and lowest ratings, we analyzed app comments to identify both negative and positive aspects that users complain about or want to maintain in the apps. As a result, we obtained a set of 14 requirements and 49 quality attributes that could be useful to understand the users' expectations and what to maintain or remove to meet their needs.

The remainder of this paper is organized as follows. In Section 2, we present a background on mobile digital libraries, while discussing work related with this research. In Section 3, we present our research methodology. Section 4 presents our results with a list of requirements and quality attributes for mobile digital libraries. Finally, our conclusions and future work are described in Section 5.

2   Background

2.1   Quality in Mobile Digital Libraries

Mobile applications are getting a great deal of interest among researchers due to their proliferation and pervasiveness, especially in the context of digital libraries of educational institutes [14]. Hence, the use of mobile devices in providing library services is an alternative for satisfying the needs of the users regarding access to educational contents. Mobile digital libraries can support user by [13]: (a) bringing the library closer to the users making it easier to use and increasing

its usage; (b) using computing power to find information; (c) making it available to access digital information on a network at lower costs; and (d) updating important information continually.

Due to the COVID-19 pandemic there has been a significant growth in the adoption of mobile digital libraries [4]. As public libraries were affected, mobile digital libraries remained active and available to users so that they could access to their digital content [4]. Thus, several quality attributes have been indicated by both industry and academy for designing useful and usable digital libraries [2].

According to Cane (2012), there are several features that impact the satisfaction of users with digital libraries:

Information Quality data reliability is a key component in the analysis of an effective computer- based data system. Attributes are usually associated with consistency, design, timeliness, currency, reliability, completeness, accuracy, and significance.

System Quality System quality affects the perception of users of the performance of a digital library in knowledge assortment and delivery. In the development of information systems, the quality cycle of the systems is a strong determinant for user satisfaction in various contexts. In this aspect, Accessibility, accuracy, reliability, and quality are the key attributes of performance measurement.

Service Quality User perception of the performance of a digital library in the processing and distribution of information is characterized by service quality. One of the prominent qualities of digital service performance is accession, reliability, accessibility, and responsiveness.

Perceived Ease of Use The perceived ease of use is defined as the degree to which an individual believes that it would be effortless to use a particular system. In this context, user friendliness indicates a belief that using DL would require minimal effort. Also, accessibility is sometimes related to ease of use.

Considering the impact of Mobile Digital Libraries in the context of online education, several studies have been conducted regarding the identification and proposal of requirements to meet quality standards so that software development teams have indicators on what users' require [17,16]. Below, we present some researches in which these requirements and/or quality attributes have been presented and/or applied.

2.2 Requirements in Digital Libraries

According to Dubbels , requirements play a central role in educational platforms since even though having evidence-supported requirements is not possible, there are techniques that can help generate and test insights as part of an iterative process, culminating incremental improvement of requirements, models, and testing. Furthermore, having a list of requirements can be useful for the development

team, as it can be used as an early artifact in the software development process which is further mapped into the software requirements specification [15]

In the context of Mobile Digital Libraries, there has been an increased interest in understanding what are the features and attributes that this type of application should provide [7]. For instance, Xie et al. (2020) identified features to enhance the usability of digital libraries for blind and visually impaired users. According to the authors, multiple data collection methods were applied to obtain data on usability problems in digital libraries, including pre-questionnaires, think-aloud protocols, transaction logs, and pre and post search interviews. Among some of the features the authors list for improving usability for visually impaired, we can list: (a) Provide added description or clear labels; (b) Provide instruction and context-sensitive help for features and web pages; (c) Improve ease of navigation and increase access points; (d) Modify text or spacing elements to eliminate confusion of screen reader interpretation; (e) Enhance search functions or add new search features; and (f) Modify multimedia items (e.g., change start time of video to eliminate delay). Although the attributes are applicable to most digital libraries, the improvements can mostly me useful for the visually impaired, and few examples of requirements and attributes for broader users are presented.

In another work, Wei et al. (2015) shows quality attributes that impacted the usability and user experience of a mobile digital library app. The authors applied a usability testing, using pre-test questionnaires, accomplishing tasks, and post-test surveys. The authors make some recommendations, such as: (a) Adjustment of the location and identification label of the functional module; (b) Optimization of search functions and promotion of searching efficiency; and (c) Offer human-oriented and user-friendly operations based on smartphone characteristics. Nevertheless, these features are specific for the application that they evaluated and there are few examples of requirements that could be implemented to provide a positive user experience and/or improve the ease of use of the mobile digital library.

Finally, other researchers have applied traditional usability evaluations to determine whether a digital library met users' expectations [8]. The authors employed traditional usability evaluation heuristics [12] to assess the quality of the app. Although the heuristics are generic and can be applied in mobile digital libraries, they do not allow evaluating the specifics of this type of software. Thus, making it difficult to identify aspects that users of digital libraries could require to improve their experience and achieve their goals.

After considering several research papers on quality attributes of mobile digital libraries, we did not find a complete list of requirements that could be met to develop high quality digital libraries in the mobile context. Also, although there are suggestions of attributes that could improve the usability of mobile digital libraries, these attributes are not specific for this type of software or are not complete, as they are based on the evaluation and analysis of a single application. Consequently, there is a need to support software development teams

in the definition of requirements that they will include during the design of a mobile digital library or during their validation.

There are several approaches to evaluate the quality of VLEs and their contents. Mastan et al. (2022) carried out a systematic literature review and identified 38 publications describing approaches evaluating a range of quality criteria in VLEs, such as: usability, quality of service, learning performance, user satisfaction, technology adoption, and others. Within the context of usability and user experience evaluation, several approaches have been developed. To meet this gap, in the following section we describe how we carried out a feature analysis of existing mobile digital libraries in Brazil and the evaluation comments of their users.

3   Research Methodology

We carried out an analysis of Brazilian mobile digital libraries available in the Google Play app store. The goal was to read the documentation provided by the developers on the features presented in these applications and explore the applications to experience their features.

In all, we selected 20 mobile digital libraries (due to convenience), prioritizing those with more than 50,000 downloads and a rating 4 or above, to guarantee that these mobile applications where in use and provided useful resources to users to incite download. To reach at least 20 applications with mixed reviews, we also considered those with less downloads or scores, but had at least 100 reviews, indicating improvement opportunities.

Table 1 shows the requirements we identified based and the set of mobile digital libraries that have these features. We highlight that the data for this analysis was obtained in Brazilian app stores in February 2022 and updated in May 2022. The applications that we considered are listed bellow.

- APP01 - Kindle[5]
- APP02 - Árvore Livros[6]
- APP03 - PocketBook reader[7]
- APP04 - Deseret Bookshelf[8]
- APP05 - Let's Read - Digital Library[9]

---

[5] `https://play.google.com/store/apps/details?id=com.amazon.kindle` Accessed on: May 23rd, 2022

[6] `https://play.google.com/store/apps/details?id=arvoredelivros.com.br.arvore` Accessed on: May 23rd, 2022

[7] `https://play.google.com/store/apps/details?id=com.obreey.reader` Accessed on: May 23rd, 2022

[8] `https://play.google.com/store/apps/details?id=com.deseretdigital.bookshelf` Accessed on: May 23rd, 2022

[9] `https://play.google.com/store/apps/details?id=org.asiafoundation.letsread` Accessed on: May 23rd, 2022

- APP06 - Skeelo: livros digitais[10]
- APP07 - Biblioteca Virtual by Pearson[11]
- APP08 - Ebook Reader[12]
- APP09 - Biblion: é gratuita, é de SP[13]
- APP10 - Google Play Livros[14]
- APP11 - FBReader [15]
- APP12 - Ler livros digitais - Kobo Books [16]
- APP13 - Aldiko Next [17]
- APP14 - Glose [18]
- APP15 - 50000 eBooks AudioBooks (Oodles) [19]
- APP16 - Bookplay[20]
- APP17 - Biblioteca Digital Senac[21]
- APP18 - Biblioteca Pública Digital [22]
- APP19 - BDEscolar[23]
- APP20 - Minha Biblioteca[24]

---

[10] `https://play.google.com/store/apps/details?id=br.com.gold360.skeelo` Accessed on: May 23rd, 2022

[11] `https://play.google.com/store/apps/details?id=com.minha.biblioteca` Accessed on: May 23rd, 2022

[12] `https://play.google.com/store/apps/details?id=com.ebooks.ebookreader` Accessed on: May 23rd, 2022

[13] `https://play.google.com/store/apps/details?id=es.odilo.saopaulopl` Accessed on: May 23rd, 2022

[14] `https://play.google.com/store/apps/details?id=com.google.android.apps.books` Accessed on: May 23rd, 2022

[15] `https://play.google.com/store/apps/details?id=org.geometerplus.zlibrary.ui.android` Accessed on: May 23rd, 2022

[16] `https://play.google.com/store/apps/details?id=com.kobobooks.android` Accessed on: May 23rd, 2022

[17] `https://play.google.com/store/apps/details?id=com.aldiko.android` Accessed on: May 23rd, 2022

[18] `https://play.google.com/store/apps/details?id=com.glose.android` Accessed on: May 23rd, 2022

[19] `https://play.google.com/store/apps/details?id=com.oodles.download.free.ebooks.reader` Accessed on: May 23rd, 2022

[20] `https://play.google.com/store/apps/details?id=air.com.mundialeditora.bookplay` Accessed on: May 23rd, 2022

[21] `https://play.google.com/store/apps/details?id=br.com.senac.editoradigital` Accessed on: May 23rd, 2022

[22] `https://play.google.com/store/apps/details?id=es.odilo.dibam` Accessed on: May 23rd, 2022

[23] `https://play.google.com/store/apps/details?id=es.odilo.cra` Accessed on: May 23rd, 2022

[24] `https://play.google.com/store/apps/details?id=com.minha.biblioteca` Accessed on: May 23rd, 2022

Table 1: Feature analysis of the 20 selected Brazilian mobile digital libraries

Code	App	Score
APP01	Kindle	4,9
APP02	Árvore Livros	4,7
APP03	PocketBook reader	4,6
APP04	Deseret Bookshelf	4,6
APP05	Let's Read - Digital Library	4,6
APP06	Skeelo livros digitais	4,5
APP07	Biblioteca Virtual by Pearson	4,4
APP08	Ebook Reader	4,3
APP09	Bibliom	4,3
APP10	Google Play Livros	4,1
APP11	FBReader	4,1
APP12	Ler livros digitais Kobo Books	4
APP13	Aldiko Next	4
APP14	Glose	3,7
APP15	50000 eBooks & AudioBooks (Oodles)	3,3
APP16	Bookplay	3,2
APP17	Biblioteca Digital Senac	3
APP18	Biblioteca Pública Digital	2,8
APP19	Biblioteca Digital Escolar CRA	2,3
APP20	Minha Biblioteca	2,2

Evaluations	2 440 000	13 700	81300	2340	2040	30600	2 180	92112	359	1910000	222000	275749	215000	2090	58 800	4230	119	8 990	1 610	291
RF01	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x
RF02	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RF03	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RF04	x	x	x	x	x	x	x		x	x			x	x	x		x	x	x	x
RF05	x					x				x		x		x	x	x			x	x	x
RF06	x	x	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x
RF07	x	x		x	x		x		x	x	x	x	x	x			x	x	x	x
RF08	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
RF09	x	x	x	x	x		x		x	x		x	x					x	x	x
RF10	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x
RF11	x				x							x		x				x	x	
RF12														x						
RF13	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
RF14	x									x				x				x	x	x
Percentage	92%	71%	64%	71%	71%	64%	64%	42%	64%	85%	50%	71%	71%	92%	64%	50%	64%	92%	92%	85%
Total	13	10	9	10	10	9	9	6	9	12	7	10	10	13	9	7	9	13	13	12

Considering that users' opinions about a mobile application also contain information about its positive or negative aspects [10], we decided to analyze app comments from the top rated and least rated mobile digital libraries apps, to guarantee both positive and negative aspects. Due to a large number of comments from the applications, samples were defined to facilitate collection and analysis. For this, we selected 100 comments for each selected app. In all, we selected 12 apps from the original list of mobile digital libraries in Table 1 (see highlighted apps). The apps were selected based on the scores of the apps, guaranteeing having apps with both low and high scores. Also, when scores wee the same and there was the possibility of having another app with a different average score, with more comments, we tried to include it in order to diversify our sample of comments.

Once the apps were selected, their comments were extracted according to the order of appearance. The collection was done manually by two software engineering researchers and the comments were stored in a database. With the set of comments, we applied the following classification process. The texts of the comments were read and labeled in quality attributes considering positive and negative points that can affect the quality of a mobile digital library. The list of quality attributes was initialized empty, and as the sorting process took place, new items were added. If a comment had an association with more than one attribute in the list, it was categorized with all attributes with which it had an association. In addition, the classification was revised by two other researchers to reduce the number of inconsistencies or wrong classifications. Table 2 shows the list of selected mobile digital libraries from which we selected the evaluation comments of the users.

Table 2: List of selected apps for extracting users' evaluation comments

	Code	Name	Score	Evaluation
	APP01	Kindle	4,9	2440000
	APP02	Árvore Livros	4,7	13700
$\geq 3,5$	APP03	PocketBook reader	4,6	81300
	APP06	Skeelo: livros digitais	4,5	30600
	APP07	Biblioteca Virtual by Pearson	4,4	2180
	APP08	Ebook Reader	4,3	92112
	APP15	50000 eBooks & AudioBooks (Oodles)	3,3	58800
	APP16	Bookplay	3,2	4230
$\leq 3,5$	APP17	Biblioteca Digital Senac	3	119
	APP18	Biblioteca Pública Digital	2,8	8990
	APP19	BDEscolar	2,3	1610
	APP20	Minha Biblioteca	2,2	291

4   Results

Table 3 shows the list of 14 requirements we identified through the feature analysis of the mobile digital libraries. For each considered application in the feature analysis, we extracted which functionalities it provided and related them to the app in Table 1. The code of the Requirement/Functionality (RF) is now next to its description in Table 3.

Table 3: Identified requirements based on the feature analysis of the considered Brazilian mobile digital libraries

Code	Requirement Description
RF01	The system must provide general information for each resource (Title, Abstract, Authors, Rating, Image)
RF02	The system must provide a resource catalog
RF03	The system should allow searching for a resource in the catalog
RF04	The system must present information about the Terms and Conditions of Use
RF05	The system must provide a dictionary function
RF06	The system should allow creating, editing, highlighting of notes/comments
RF07	The system must have a shelf with favorite features
RF08	The system must have a shelf with a history of consumption to facilitate access to resources consumed and with consumption in progress
RF09	The system should provide a list of news
RF10	The system should provide a list of recommendations
RF11	The system should present information on resource consumption statistics
RF12	The system must have features to engage the student, such as competition and gamification
RF13	The system should allow using the resources offline
RF14	The system should allow the user to evaluate a resource

Note that even though some applications provide the same number of functionalities (e.g. APP01, APP14, APP18 and APP19) in Table 1, their scores are not the same. Therefore, analyzing the users' evaluations comments could be useful for identifying further quality attributes. Hence, Table 4 shows the 49 Quality Attributes (QA) we identified. Each of the quality attributes was categorized in either Functionality or Quality of Use. In terms of functionality, we considered attributes that denoted new functionalities that the application should provide, such as: providing notifications (QA01), providing further information on the consumption process of a resource within the library (QA03), generating reports (QA09), and others. Also, in terms of quality in use, we considered aspects that made it easier to use the application and/or (could) improved the user experience, such as: visual support in terms of colors (QA19), customization of page size (QA29), or provide shortcuts for experienced users (QA42), and others.

Table 4: Identified quality attributes based on the analysis of comments made during evaluations of mobile digital libraries

Code	Category	Quality Attribute
QA01	Functionality	The system must send notifications when receiving files
QA02	Functionality	The system must support different file formats
QA03	Functionality	The system must show reading progress such as pages read and total pages
QA04	Functionality	The system must allow searching for terms within a resource
QA05	Functionality	The system must allow importing resources
QA06	Functionality	The system must allow to create handwritten notes
QA07	Functionality	The system must allow to create notes apart from resources
QA08	Functionality	The system must provide automatic translations for resources that do not have official translations
QA09	Functionality	The system must present statistics on resource consumption such as daily/monthly/annual reading time, total reading time of a book
QA10	Functionality	The system must provide an achievement system (gamification)
QA11	Functionality	The system must present to the user new resources available on the platform
QA12	Functionality	The system must provide a bookshelf, arranging the books in: already read, desired and in progress
QA13	Functionality	The system must provide a quick access tab to the chapters and pages of a resource
QA14	Functionality	The system must allow choosing which pdf reading engine to use
QA15	Functionality	The system must allow factory reset the settings
QA16	Functionality	The system must allow auto-scrolling
QA17	Functionality	The system must allow navigating the resource using the cell phone's volume buttons
QA18	Functionality	The system must sync with cloud services and third-party apps and be able to connect to other devices and external web/mobile platforms
QA19	Quality of Use	The system must provide a dark mode to assist the visually impaired
QA20	Quality of Use	The system should allow changing of the marking color a resource's section
QA21	Quality of Use	The system must provide a widget with a shortcut to the feature in use on the home page
QA22	Quality of Use	The system must offer a free demo of the resource within the library so that the reader can decide whether or not to consume the resource

Code	Category	Quality Attribute
QA23	Quality of Use	The system must allow to adjust the luminosity (brightness scale)
QA24	Quality of Use	The system must allow to highlight the text
QA25	Quality of Use	The system must provide a page with all the bookmarks of the book
QA26	Quality of Use	The system must provide a voice over of the resource
QA27	Quality of Use	The system must allow bookmarks
QA28	Quality of Use	The system must allow to create notes about a section from the book
QA29	Quality of Use	The system must allow to adjust the page size through zoom
QA30	Quality of Use	The system must allow to customize the font, such as format, size and color
QA31	Quality of Use	The system must allow horizontal reading
QA32	Quality of Use	The system must provide the search by author, title or keyword
QA33	Quality of Use	The system must provide the creation of lists, categories or sections for organizing resources
QA34	Quality of Use	The system must allow to download of books for offline access
QA35	Quality of Use	The system must provide an integrated dictionary for searching the meaning of a word
QA36	Quality of Use	The system must provide a wish list in the app
QA37	Quality of Use	The system must allow sharing a link to a title
QA38	Quality of Use	The system must provide the name of the translator who did the localization
QA39	Quality of Use	The system must allow to create folders or categories to classify the notes
QA40	Quality of Use	The system must provide recommendations based on previously consumed resources
QA41	Quality of Use	The system must prevent the screen from turning off while the user is consuming a resource
QA42	Quality of Use	The system must automatically save the position the user was within the resource
QA43	Quality of Use	The system must allow the user to select which languages to find the resources
QA44	Quality of Use	The system must allow the user to find the actual page number for reference purposes
QA45	Quality of Use	The system must present an estimate of time to finish a resource and part of the resource
QA46	Quality of Use	The system must keep the books in its catalog and notify users in advance of the withdrawal of a book

Code	Category	Quality Attribute
QA47	Quality of Use	The system must smooth the screen transitions and keep them at an acceptable speed
QA48	Quality of Use	The system must resize the text according to the screen size
QA49	Quality of Use	The system must be available in the local language

5   Conclusions and Future Work

To support the design of high quality mobile digital libraries, we carried out an analysis of real applications in the market, identifying requirements that provide functionalities for users. Also, the list of quality attributes from the point of view of users is relevant to understand the users' expectations and understand what to maintain or remove when designing and developing a mobile digital library.

We are currently employing the proposed requirements list for the development of a new mobile digital library. As the next steps of this work, we intend to carry out empirical studies to analyze if by meeting the identified requirements and including the quality attributes, we can improve the effectiveness, efficiency, and the overall acceptance of the new proposed mobile digital library from the point of view of users in real usage scenarios. In addition, we intend to refine this list of requirements and quality attributes to propose a set of heuristics and guidelines for the development of usable and useful mobile digital libraries considering the users expectations. Through this research, we intend to provide a more reliable and robust requirements and quality attributes list suitable for use by the software industry, as well as software engineers in the development of mobile digital libraries.

References

1. Alfaresi, S.H., Hone, K.: The intention to use mobile digital library technology: a focus group study in the united arab emirates. International Journal of Mobile Human Computer Interaction (IJMHCI) **7**(2), 23–42 (2015)
2. Blandford, A., Buchanan, G., Jones, M.: Usability of digital libraries. International Journal on Digital Libraries **4**(2), 69–70 (2004)
3. Cane, F.K.: Service quality of digital libraries and users satisfaction. Advancement In Education, Management, Science And Technology **4**(3) (2012)
4. Ćirić, J., Ćirić, A.: The impact of the covid-19 pandemic on digital library usage: a public library case study. Journal of Web Librarianship **15**(2), 53–68 (2021)
5. Curcio, K., Navarro, T., Malucelli, A., Reinehr, S.: Requirements engineering: A systematic mapping study in agile software development. Journal of Systems and Software **139**, 32–50 (2018)
6. Dubbels, B.R.: Requirements-based design of serious games and learning software: an introduction to the vegas effect. In: Exploring the cognitive, social, cultural, and psychological aspects of gaming and simulations, pp. 1–34. IGI Global (2019)
7. Franzini, G., Terras, M., Mahony, S.: Digital editions of text: surveying user requirements in the digital humanities. Journal on Computing and Cultural Heritage (JOCCH) **12**(1), 1–23 (2019)

8. Fung, R.H.Y., Chiu, D.K., Ko, E.H., Ho, K.K., Lo, P.: Heuristic usability evaluation of university of hong kong libraries' mobile website. The Journal of Academic Librarianship **42**(5), 581–594 (2016)
9. Høivik, J.: Mobile digital library in the national library of norway. Library Hi Tech News (2011)
10. Khalid, H., Shihab, E., Nagappan, M., Hassan, A.E.: What do mobile app users complain about? IEEE software **32**(3), 70–77 (2014)
11. Li, H., Cai, Z.Q.: Design and implementation of the mobile library app based on smart phone. In: 2016 International Conference on Machine Learning and Cybernetics (ICMLC). vol. 1, pp. 318–322. IEEE (2016)
12. Nielsen, J.: Usability inspection methods. In: Conference companion on Human factors in computing systems. pp. 413–414 (1994)
13. Oinam, A.C., Thoidingjam, P.: Impact of digital libraries on information dissemination. International Research: Journal of Library and Information Science **9**(1) (2019)
14. Rafique, H., Almagrabi, A.O., Shamim, A., Anwar, F., Bashir, A.K.: Investigating the acceptance of mobile library applications with an extended technology acceptance model (tam). Computers & Education **145**, 103732 (2020)
15. Ramdhani, M.A., Maylawati, D.S., Amin, A.S., Aulawi, H.: Requirements elicitation in software engineering. International Journal of Engineering & Technology (UEA) **7**(2.19), 772–775 (2018)
16. Wei, Q., Chang, Z., Cheng, Q.: Usability study of the mobile library app: an example from chongqing university. Library Hi Tech (2015)
17. Xie, I., Babu, R., Lee, T.H., Castillo, M.D., You, S., Hanlon, A.M.: Enhancing usability of digital libraries: Designing help features to support blind and visually impaired users. Information Processing & Management **57**(3), 102110 (2020)