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Development and validation of a measuring instrument for digital library maturity

Fatemeh Sheikhshoaei [a], Nader Naghshineh [b], Sirous Alidousti [c], Maryam Nakhoda [b], Hossein Dehdarirad [a,*]

[a] School of Allied Medical Sciences, Tehran University of Medical Sciences; No.17, Fardanesh Alley, Qods Street, Enqelab Street, Tehran 1417744361, Iran
[b] Faculty of Management, University of Tehran, Crossroad of Chamran and Jalal Al Ahmad Highway, Next to Tarbiat Modarres Metro Station, Tehran 1411713114, Iran
[c] Iranian Research Institute for Information Science and Technology (IranDoc), No. 1090, Enqelab Eslami Ave., Tehran 1315773314, Iran

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ABSTRACT

Development of a digital library demands extensive financial, human, and technological investments. Appropriate models and measurement tools are required to achieve the goals of these libraries to assess them. This research was conducted with the aim of developing and validating a tool to measure the maturity of a digital library based on the "digital library maturity model" (DLMM). Two sources including literature and experts' opinion were used to determine the criteria for each code. Expert opinion and confirmatory factor analysis were used to confirm the content and construct validity of the developed tool, respectively. The reliability of the designed tool was examined by the Cronbach's alpha test. Finally, the designed tool validity and reliability were confirmed. Managers of digital libraries can use this tool to understand the maturity level of their digital libraries and plan to improve the library or to attain advanced levels of maturity.

1. Introduction

Given the rapid and continuous advances in information and communication technologies, libraries are subject to changes. These changes have transformed traditional libraries into digital libraries (Mahesh & Mittal, 2008). As described by the Digital Library Federation (DLF), digital libraries are "organizations that provide resources, including specialized staff to select, organize, enable access, interpret, distribute, protect the integrity, and ensure sustained existence of digital collections in such a way that the collections are readily and cost-effectively available to be used by a defined community of users" (Digital Library Federation, 1998).

Digital libraries have greatly changed the provision of resources and knowledge. Users of digital libraries can have easy access at any time to a wide variety of digital texts from all over the world to search, browse, and retrieve from digital texts according to their needs (Yung-Ming, 2014). In general, the development of digital libraries in the world is welcomed and inspired and efforts to develop these libraries seem to be underway worldwide (Abdul Rahman & Mohezar, 2020).

Nevertheless, the development of digital libraries requires extensive funds, human resources, and technologies. Therefore, assessments aimed at ensuring that digital libraries have achieved their predetermined goals are inevitable (Noorman & Eric, 2016). In line with the needs and expectations of their beneficiaries, organizations are faced with modifications and improvements to increase their competence and capabilities. Maturity models are considered as common important tools for organizational support in this regard (Lindemulder, 2015). Maturity models are described as a set of hierarchies that altogether traverse a predicted or rational path from a basic state to the ultimate maturity state (Proença & Borbinha, 2016). These models are able to measure various aspects of a process or organization: (1) benchmarking criterion and auditing index, (2) an indicator to assess progress vs. objectives, and (3) insight to recognize the strengths, weaknesses, and opportunities.

2. Problem statement

Digital libraries face many difficulties and challenges, including technical, economic, social, and legal. These challenges arise from the complex environment of this type of library, which creates many barriers to their services. Examining digital libraries and similar

* Corresponding author.
E-mail address: Dehdari.hossein@gmail.com (H. Dehdarirad).

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phenomena such as e-government, e-commerce, and e-learning that have emerged as a result of the impact of information technology (IT) on an organization or phenomenon, it was found that many of them have tried to use management models (e.g., maturity models and change models) to better manage these phenomena (Patas, 2012; Poeppelbuss, Niehaves, Simons, & Becker, 2011; Wendler, 2012).

The use of maturity models in a digital library as an organization (based on the definition of DLF) can assistance progress in its performance and pave the way to an optimal digital library. The application of maturity models in organizations is an appropriate and tested method (Khatibian, Hasan Gholoi Pour, & Abedi Jafari, 2010; Wendler, 2012). Therefore, it is necessary to specify the development stages of digital libraries in the form of models (such as maturity models) to conduct planning and management of these organizations more efficiently.

However, most constructs of the models built and examined in social science research are not directly measurable. Usually, the constructs of such models are hidden in the phenomenon being studied. To examine the constructs of these models, appropriate criteria should be designed to act as representatives or alternatives of them. This is also true in IT/systems studies, and the design of alternative criteria for the measurement of many constructs should be considered (Straub, 1989). Accordingly, it is difficult to measure the maturity only by designing a digital library maturity model, because the maturity model is associated with complexity, high expenses, and time consumed as well as confusion for managers and assessors. To objectively assess the maturity of digital libraries, it is necessary to set criteria for each construct of a model to avoid different interpretations of each construct, and thus, correctly assess the maturity of digital libraries.

A review of the research showed that no tool has yet been developed to measure the maturity of digital libraries. Only one maturity model (Sheikhshoaei, Naghshineh, Alidousti, & Nakhoda, 2018) was found that examined all aspects of digital libraries, and other models in this area usually focus on one aspect of these libraries. In the Digital Library Maturity Model (DLMM) developed by Sheikhshoaei et al. (2018), 39 codes have been attained, and these codes are broad. On the other hand, people who use this model for evaluation may have different interpretations of each code. Therefore, having more detailed criteria that specify what each code examines can help clarify this model and reduce the complexity of the digital library maturity assessment process. Thus, developing a tool based on this model could be essential for effective and functional measurement of the maturity of digital libraries. The aim of this study was to develop a tool (in the form of a questionnaire) based on the maturity model designed by Sheikhshoaei et al. (2018), and to measure the validity and reliability of the new tool.

3. Literature review

Maturity models have been developed with the appearance and usage of IT. They are, in fact, considered in the field of IT management. These models have been designed and applied in a variety of areas such as e-government (Fath-Allah, Cheikhi, Al-Qutaish, & Idri, 2014), knowledge management (Jiankang, Jiuling, Qianwen, & Kun, 2011), e-commerce (Morais, Gonçalves, & Pires, 2007), and e-learning (Marshall & Mitchell, 2004). There have also been studies on maturity measurement tools in some different areas like: smart cities (Warnecke, Wittstock, & Teuteberg, 2019), risk management (Cech, Januska, & Faifr, 2018), industry (Siebelink, Voordijk, & Adriaanse, 2018; Ünal & Köhler, 2019), and food manufacturing (Jespersen, Griffiths, Maclaurin, Chapman, & Wallace, 2016).

The studies that have presented maturity models in libraries have focused on a specific function or service like social media (Zhu, Song, & Sun, 2016), knowledge management (Yang & Bai, 2009; Z.Y. Yang, Zhu, & Zhang, 2016), preservation policy for libraries and archives (Gkinni, 2014), IT (Nadjla Hariri & Sheikhzadeh, 2013), and maturity model of digital library as a whole (Sheikhshoaei et al., 2018). Furthermore, the studies mentioned here are usually limited to a specific country. A notable point is that such investigations have provided little information regarding how they have developed their models.

Zhu et al. (2016) presented a maturity model at five levels (including initial, planning, management, integration, and optimization) in five parts (including library, librarian and organization, process, counseling, and service performance) for evolution of social network service in academic libraries in addition to measures required to improve the quality and level of service. They offered a maturity model for social media but did not consider other services in academic libraries.

Based on the capability maturity model for knowledge management in digital libraries, Z.Y. Yang et al. (2016) developed a five-level maturity model, which included the following levels: original, repeatable, general, management, and innovation. Each level had its own key process area and practices for maturity. The study of Yang et al. solely focused on knowledge management in the digital libraries of China but did not address other topics of digital libraries.

Yang and Bai (2009) suggested a maturity model for knowledge management in college libraries. The proposed maturity model is based on the capability maturity model and has five levels, each of which shows one step in improving the knowledge management process. Five knowledge management processes are based on five levels of the model as follows: confounded, perceived and iterative, standardized and concordant, quantitated, and continuously improved. In this model, three capabilities have been considered for knowledge management involving culture, structure, science and technology. They reviewed the concept of knowledge management only in one type of library, i.e., college library.

Gkinni (2014) used the maturity model to maintain resources in libraries and archives in three levels, including documentation of scope, design and content, and test phase. Gkinni designed a tool for maturity of policies to protect the collections of libraries and archives in Greece, which was more comprehensive so that a variety of libraries and archives such as “public”, “municipal”, “academic and bank libraries”, and “General State Archives” could apply the tool.

Hariri and Sheikhzadeh (2013) presented a model for maturity of IT in Iranian university libraries with four dimensions, including applications, users, resources, and management. The study did not address other topics of university libraries.

Sheikhshoaei et al. (2018) designed a maturity model for digital libraries based on the capability maturity model (CMM), which has five levels, three categories, seven concepts, and 39 codes (See Appendix A, Table 1). To design the model, they used a qualitative approach with meta-synthesis and Delphi technique. In this study, digital libraries were considered as a whole, and different aspects of the library were reflected.

On the other hand, studies related to the development of tools in libraries have dealt with issues such as making a tool for measuring usability of digital libraries. The study of Joo and Yeon Lee (2011) dealt with the development and validation of a tool to measure usability in digital libraries. In this investigation, four dimensions have been considered for usability, including “efficiency”, “effectiveness”, “satisfaction”, and “learnability”. Limitations of this study were as follows: focusing only on the usability dimension of digital libraries, not involving experts in the process of “instrument identification”, not recruiting faculty members in sampling to confirm the validity of the tool, and restricting the study to South Korea. Koohang (2004) developed a tool to evaluate the usability of digital libraries from the viewpoint of users and presented a tool consisting of 12 components. Limitations of this study were only recruiting undergraduate students, no consideration of other digital library users, and its implementation only in the United States of America.

Kyrillidou and Giersch (2005) developed a tool to manage digital library services. The researchers used gap theory and the SERVQUAL tool to measure the gap between users’ expectation of service quality with what they actually received and perceived. This tool was designed to evaluate the quality of the United States National Science Digital Library.

4. Method

4.1. Development of the maturity measurement tool

This applied research has adapted a mixed method approach using a questionnaire and the Delphi method. A digital library maturity measurement tool was developed and validated in four steps (Fig. 1). This tool was developed based on the maturity model designed by Sheikhshoaei et al. (2018). The first step was to determine the criteria for each of the 39 codes of the digital library maturity model (Sheikhshoaei et al., 2018). To collect data in this step, previous studies and experts' opinions on digital libraries and maturity models were used and an initial set of criteria for each code was generated. Criteria for 34 codes were extracted from related literature used by Sheikhshoaei et al. (2018) in their study, as well as other relevant literature. For the other 5 codes suggested by the experts, the people who provided these codes were identified through communication with the corresponding author of Sheikhshoaei et al. (2018) article. Then, they were asked to offer criteria related to the proposed code.

In the second step, to verify the content validity of these criteria, several experts in the digital libraries and maturity models' field were identified and contacted, finally 4 experts collaborated with this research. an initial set of criteria was given to the panel of experts consisting of two faculty members in the field of digital libraries and two others in the field of IT management and maturity model. The panel was asked to read the questionnaire and comment on the following issues by leaving marks or notes on it: necessity of criteria, inconvenient to the respondents, misinterpretation of criteria, monotonous criteria, need to read the criteria several times, difficulty in reading the criteria, and inadequate criteria. These factors were taken from the Alidousti (2005) research and expert opinions were applied to the criteria according to these factors and amendments were made if necessary. An initial version of the questionnaire was designed based on the findings of this step.

In the third step, confirmatory factor analysis was used to confirm the construct validity of the questionnaire. The purpose of using this approach is to confirm the validity of the criteria with the help of the factor load obtained by the criteria in the process of confirmatory factor analysis and, if necessary, to modify the criteria.

Convergent validity and discriminant validity tests were used to calculate the construct's validity. Convergent validity means measuring the degree of explanation of a factor by its variables (Barclay, Thompson, & Higgins, 1995). The factors are each of the 39 codes and the variables are the criteria for each of the codes. In convergent validity, it examines the degree to which each code correlates with its own criteria. Average variance extracted (AVE) measure was used by the SmartPLS software for this purpose. Fornell and Larcker (1981) reported a suitable value of 0.5 and above for AVE.

Discriminant validity measures the ability of a reflective measurement model to differentiate the criteria of a code from other criteria in the model. If a code is more correlated with its own criteria than with other codes, the appropriate discriminant validity of the model is confirmed. There are two tests for discriminant validity in the SmartPLS software. In cross-loadings test, the factor loads of each variable on its factor must be at least 0.1 more than the factor loads of the same variable on other factors (Gefen & Straub, 2005). In the Fornell and Larcker (1981) test, discriminant validity is acceptable when the amount of AVE for each code is greater than the co-variance between that code and the other codes (i.e., the square of the correlation coefficients between the codes).

The quality of reflective measurement tool was calculated by CV-Communality (CV Com). This index measures the ability of the path model to predict the variables through the values of their corresponding factors. Positive values of this index indicate the appropriate quality of the reflective measurement model.

To measure the confirmatory construct validity of the tool, the questionnaire designed in the previous step was submitted to 350 directors, deputies, experts, and librarians of digital libraries to be tested and validated. These participants were selected using the key informant method at Iranian Ministry of Health and Medical Education (MOHME). A key informant is a person with considerable knowledge of a research topic because of his/her special social status. Relative to ordinary employees, key informants of the organizations can transfer more information because of their position in the organization (Nakhoda, 2010). Key informants were chosen with the aim of finding staff, to examine the validity of the questionnaire designed in this research who were aware of the concept of digital library and had experience working with this type of library.

The questionnaires were collected in both printed and electronic versions. In the electronic version, the questionnaire was sent in the Microsoft Word format to the e-mail of those who were not present. Out of the 182 completed questionnaires, 152 were gathered through e-mail and 30 in printed form submitted by the subjects. The questionnaires

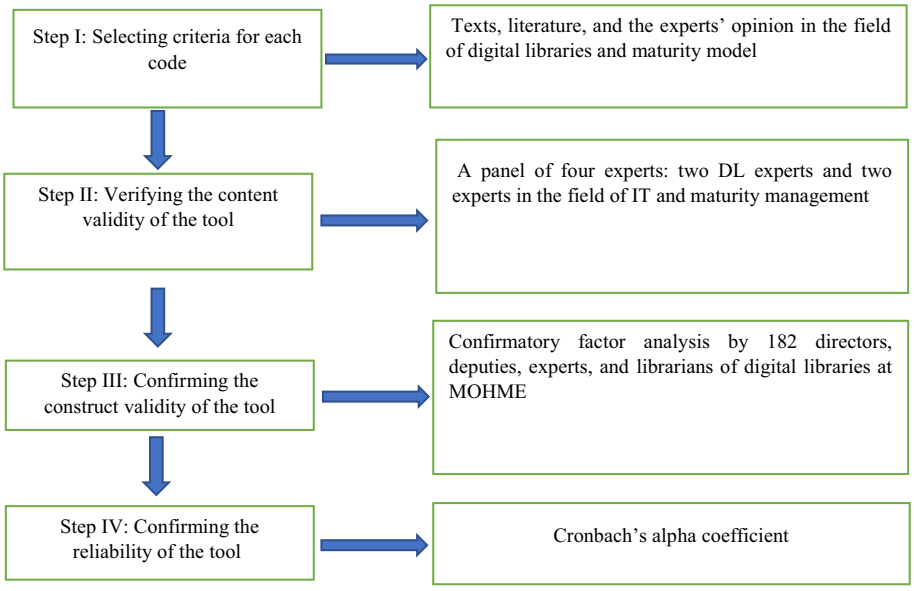

Fig. 1. Development and validation process of DLMM tool.

were distributed on September 22, 2018 and collected on October 21, 2018.

For analyzing the collected data, firstly, the demographic characteristics of respondents such as gender, age, work history in public sector, employment status, and educational level were examined. Then, the SmartPLS software was used for confirmatory factor analysis of the tool.

In the fourth step, Cronbach's alpha coefficient was deployed to measure the reliability of the mentioned tool. Reliability is evaluated through three ways of measuring factor loads and their significance, Cronbach's alpha, and combined reliability. Factor load is a numerical value that determines the intensity of the relationship between a construct (code) and the corresponding criteria during the path analysis process. If the factor load value of a criterion is higher in relation to a particular construct, that criterion plays a greater role in explaining that construct. Cronbach's alpha is a measure of reliability and a good measure of internal consistency. Internal consistency indicates the degree of correlation between a construct and its criteria. In combined reliability the reliability of constructs is calculated not in absolute terms but according to the correlation of their constructs with each other.

4.2. Calculating the level of maturity

The tool was prepared in the form of a five-point Likert questionnaire. Respondents specify their degree of agreement from these five points, which include strongly disagree (1), disagree (2), undecided (3), agree (4), and strongly agree (5). To ascertain the overall maturity of an organization, the criteria assigned at relevant level must be optimal, so that the organization passes that level (Storm, Harting, Stronks, & Schuit, 2014; Valdés et al., 2011). Therefore, when all criteria of a certain level of maturity have optimal capacity (level of 3 out of 5), it can be stated that the organization has undergone a certain level of maturity (Khatibian et al., 2010). For example, if the capacity of the second level is not at an optimal level, the overall maturity level of the organization is still 2 despite the existence of codes with a capability level higher than 3 that is assigned to the next levels.

5. Results

5.1. Step I: selecting criteria for each code

In the first step of tool development, for 39 codes in the digital library maturity model (See Appendix A, Table 1), 163 criteria were selected based on the relevant literature and experts' opinions. At the end of this step, an initial set of criteria was created that included 39 codes and criteria for each code (See Appendix, Table 2).

5.2. Step II: verifying the content validity of the tool

In the second step, the initial list of codes and criteria of each code was developed in the form of a questionnaire and submitted to the panel of experts for confirmation of content validity. At the end, a modified questionnaire containing 39 codes and 120 criteria was developed, and its content was verified (Appendix A, Tables 3, 4, 5).

5.3. Step III: confirming the construct validity of the tool

Overall, 182 out of the 350 distributed questionnaires in the third step were completed, in which women had 81.3% participation rate that was higher than that of men. The majority of respondents (93 people) were in the age group of 31–40 years and the highest period of work record was in the range of 11–15 years. Over half of the subjects were librarians and held an MSc degree (Fig. 2). The findings of this step showed that the load factor of most constructs and criteria was in a high level (Appendix A, Tables 3, 4, 5). Based on the findings, the loading factor of most criteria and codes was at a high level, which shows the high correlation between codes and criteria. The higher the loading factor of a criterion in relation to a given code, the more that criterion plays a role in explaining that code.

According to Appendix A, Table 6, the results of AVE measure, which was used to confirm convergent validity, showed a value between 0.54 and 0.96. The results of the cross-loadings test, which was used to calculate the discriminant validity of the tool revealed that the factor loads of each variable on the corresponding factor were at least 0.1 more than the factor loads of the same variable on the other factors. Due to the large number of factor analysis features, it was not possible to display the table of cross-loadings test. The results of the Fornell and Larcker tests for discriminant validity indicated that the values of the main diagonal (AVE square root) of all factors were greater than the correlation value between them. Due to the large number of components, it was not possible to demonstrate a discriminant validity table using the Fornell and Larker test. The results for CV-Communality are given in Appendix A, Table 6. A shown, its value was positive in all factors (codes).

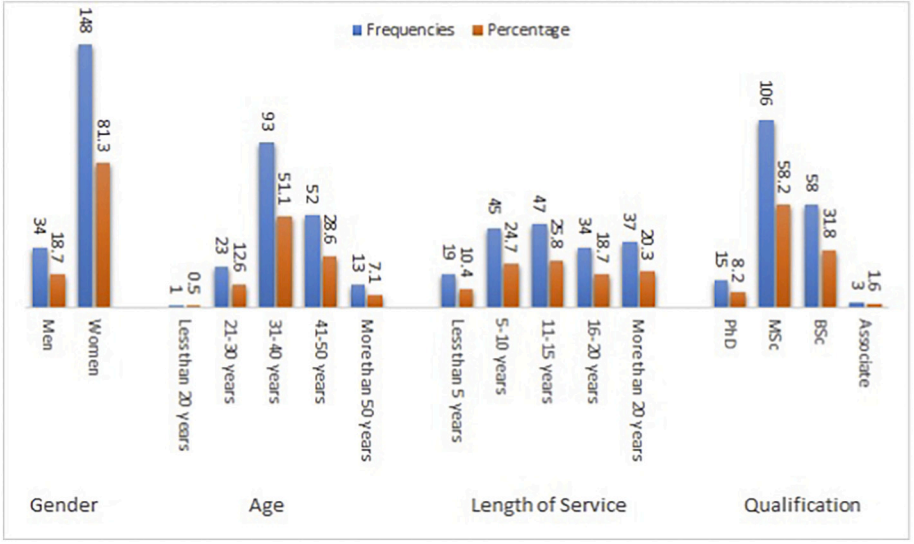

Fig. 2. Demographic attributes of the respondents.

5.4. Step IV: confirming the reliability of the tool

The findings of the fourth step showed that the Cronbach's alpha value for all factors (codes) and criteria was >0.7. The combined reliability of research variables was also >0.7 (See Appendix A, Tables 3, 4, 5).

6. Discussion

In this research, previous related studies and expert opinions were used to determine the tool criteria. Expert panel opinions were used to confirm the content validity of the tool. Confirmatory factor analysis was also employed to confirm the construct validity of the tool. According to the results of these tests, all the criteria used for assessing the characteristics of digital library maturity were confirmed. Hence, it can be concluded that this tool has sufficient validity to measure the maturity of a digital library.

Cronbach's alpha was used to confirm the reliability of the instrument. Based on the data collected in the questionnaire test step, all criteria had Cronbach's alpha coefficient > 0.7. Therefore, the reliability of the measurement model was confirmed, which indicates the internal consistency of the tool. Since the tool developed in this study has been designed in the form of questionnaire, it allows for the collection of data on a wide scale as well as the detection of the current state of maturity in digital libraries.

In this study, the researchers sought to build a tool that takes into account all aspects related to digital libraries; therefore, it is different from similar other studies that have only considered a specific function or service of digital libraries. Only a few studies have been conducted to develop tools for evaluating digital libraries, among which no research was found to deal with the design and development of a tool for measuring the maturity of digital libraries.

Joo and Yeon Lee (2011) developed a tool to assess the usability of academic digital libraries. The employed survey method to develop the tool was similar to the one described in this article, and same as the present study; they used confirmatory factor analysis and Cronbach's alpha to confirm construct validity and reliability, respectively. Unlike the present research, in which expert opinion was used to confirm content validity, they have confirmed the content validity by reviewing the related literature (Joo & Yeon Lee, 2011). The four dimensions (efficiency, effectiveness, satisfaction, and learnability) presented in Joo and Lee's study are similar to the dimensions of improvement in usability, user interface features, searchability, and accessibility in this research.

In another study, Koohang (2004) examined the usability of digital libraries from the users' point of view. Similar to this study, expert opinion and Cronbach's alpha were used for content validity and reliability, respectively. However, unlike the present research, only relevant studies were used to extract the tool criteria along with "Kaiser-Meyer-Olkin's measure of sampling adequacy test and Bartlett's test of sphericity" to confirm construct validity. Koohang (2004) considered 12 items for usability of digital libraries as follows: 1) simplicity, 2) comfort, 3) user-friendliness, 4) control, 5) readability, 6) information adequacy/task match, 7) navigability, 8) recognition, 9) access time, 10) relevancy, 11) consistency, and 12) visual presentation for the applicability of digital libraries. The items of simplicity, comfort, user-friendliness, navigability, and visual presentation are consistent with the dimensions of improvement in usability and user interface features in this research.

Wijayaratne and Singh (2015) designed two instruments, one for the web content of academic libraries, and the other one for the design features of academic libraries websites. The items of these instruments were obtained through examining related literature, observing academic library websites and visiting these libraries. Similar to the present study, confirmation of the content validity of the instruments was obtained through a panel of experts. However, the experts participating in the panel were from several different countries. Finally, the tools were designed based on several brainstorming sessions.

6.1. Limitations

In the first step of the study, to determine the criteria for each code, the researchers tried to use relevant English and Persian literature, to avoid being restricted to a particular context. However, it should be noted that since the content validity and construct validity of the tool have been tested only by experts in Iran, this study may be limited to a specific country or context. Therefore, further studies are needed to develop tools with international usability.

7. Conclusion

To the best of the researchers' knowledge, no study has been done so far to develop tools for measuring the maturity of digital libraries. This research can be considered as a basis for future studies in this area. This present study contributes significantly to the presentation of a comprehensive tool with a scientific design in the field of digital libraries and their management. Considering the appropriate validity and reliability of the developed tool, it can be introduced as a valid tool to the managers and administrators of digital libraries to assess the maturity level of their digital libraries and manage them more efficiently.

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Appendix A. Supplementary data

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References

Abdul Rahman, A. R., & Mohezar, S. (2020). Ensuring continued use of a digital library: A qualitative approach. *Electronic Library, 38*, 513–530. https://doi.org/10.1108/EL-12-2019-0294.

Alidousti, S. (2005). *Designing and explaining the model of the key factors affecting the use of information technology in the administrations of governmental organizations in industrial provinces of Iran (Case study: Fars province) (Doctoral Dissertation)*. Tehran, Iran: University of Tehran.

Barclay, D., Thompson, H., & Higgins, C. M. (1995). The Partial Least Squares (PLS) approach to causal modeling: Personal computer use as an illustration. *Technology Studies, 2*, 285–309.

Cech, M., Januska, M., & Faifr, A. (2018). Using self-assessment tool as part of risk management maturity model. In *Paper presented at International Business Information Management Association (IBIMA). Seville, Spain*. Retrieved August 7, 2020 from https://ibima.org/accepted-paper/using-self-assessment-tool-as-part-of-risk-management-maturity-model/.

Digital Library Federation. (1998). *A working definition of digital library*. Retrieved Mar. 16, 2014 from https://old.diglib.org/about/dldefinition.htm.

Fath-Allah, A., Cheikhi, L., Al-Qutaish, R. E., & Idri, A. (2014). E-government maturity models: A comparative study. *International Journal of Software Engineering & Applications, 5*, 71–91. Retrieved from http://airccse.org/journal/ijsea/papers/5314ijsea06.pdf.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39–50.

Gefen, D., & Straub, D. (2005). *A practical guide to factorial validity using PLSGraph: Tutorial and annotated example. 16* pp. 91–109). article 5. Retrieved from https://aisel.aisnet.org/cgi/viewcontent.cgi?article=3020&context=cais.

Gkinni, Z. (2014). A preservation policy maturity model: A practical tool for Greek libraries and archives. *Journal of the Institute of Conservation, 37*(1), 55–64. https://doi.org/10.1080/19455224.2013.873729.

Hariri, N., & Sheikhzadeh, M. (2013). Determining evaluation index for information technology maturity in the Iranian university libraries. *System and information services, 2*(2), 45–54. Retrieved May 27, 2018 from https://www.sid.ir/en/journal/ViewPaper.aspx?id=474185.

Jespersen, L., Griffiths, M., Maclaurin, T., Chapman, B., & Wallace, C. A. (2016). Measurement of food safety culture using survey and maturity profiling tools. *Food Control, 66*, 174–182. https://doi.org/10.1016/j.foodcont.2016.01.030.

Jiankang, W., Jiuling, X., Qianwen, L., & Kun, L. (2011). *Knowledge management maturity models: A systemic comparison*. Retrieved from: Information Management, Innovation Management and Industrial Engineering (ICIII). https://doi.org/10.1109/ICIII.2011.420.

Joo, S., & Yeon Lee, J. (2011). Measuring the usability of academic digital libraries: Instrument development and validation. *Electronic Library, 29*, 523–537. https://doi.org/10.1108/02640471111156777.

Khatibian, N., Hasan Gholoi Pour, T., & Abedi Jafari, H. (2010). Measurement of knowledge management maturity level within organizations. *Business Strategy Series, 11*, 54–70. https://doi.org/10.1108/17515631011013113.

Koohang, A. (2004). Development and validation of an instrument for assessing users' views about the usability of digital libraries. *Issues in Informing Science & Information Technology, 1*. Retrieved from http://proceedings.informingscience.org/InSITE2004/018kooha.pdf.

Kyrillidou, M., & Giersch, S. (2005). Developing the DigiQUAL protocol for digital library evaluation. In *Proceedings of the 5th ACM/IEEE-CS Joint Conference on Digital Libraries*. https://doi.org/10.1145/1065385.1065426. Retrieved from.

Lindemulder, M. (2015). *Development of a continuous improvement maturity model assessment instrument (Bachelors Thesis)*. Enschede, Netherlands: University of Twente.

Mahesh, G., & Mittal, R. (2008). Digital libraries in India: A review. *Libri, 58*, 15–24. https://doi.org/10.1515/libr.2008.002.

Marshall, S., & Mitchell, G. (2004). Applying SPICE to e-learning: An e-learning maturity model?. In *Proceedings of the Sixth Australasian Conference on Computing Education*. Australian Computer Society, Inc. https://doi.org/10.5555/979968.979993. Retrieved from.

Morais, E. P., Gonçalves, R., & Pires, J. A. (2007). *Electronic commerce maturity: A review of the principal models*. Retrieved from http://bibliotecadigital.ipb.pt/bitstream/10198/1396/1/IADISeSociety.pdf.

Nakhoda, M. (2010). *Design change management model in Iranian academic libraries (Doctoral Dissertation)*. Tehran, Iran: University of Tehran.

Noorman, M. M., & Eric, G. J. (2016). Assessing user's satisfaction with web digital library: The case of Universiti Teknologi MARA. *International Journal of Information and Learning Technology, 33*(1), 36–56. https://doi.org/10.1108/IJILT-06-2015-0019.

Patas, J. (2012). Towards maturity models as methods to manage IT for business value - a resource-based view foundation. In *Paper presented at the Americas Conference on information systems (AMCIS)*. Seattle, Washington. Retrieved from https://aisel.aisnet.org/amcis2012/proceedings/StrategicUseIT/16.

Poeppelbuss, J., Niehaves, B., Simons, A., & Becker, J. (2011). Maturity models in information systems research: Literature search and analysis. *Communications of the Association for Information Systems, 29*, 505–532. Retrieved from https://aisel.aisnet.org/cgi/viewcontent.cgi?article=3634&context=cais.

Proença, D., & Borbinha, J. (2016). Maturity models for information systems - a state of the art. *Procedia Computer Science, 100*, 1042–1049. https://doi.org/10.1016/j.procs.2016.09.279.

Sheikhshoaei, F., Naghshineh, N., Alidousti, S., & Nakhoda, M. (2018). Design of a digital library maturity model (DLMM). *Electronic Library, 36*, 607–619. https://doi.org/10.1108/EL-05-2017-0114.

Siebelink, S., Voordijk, J. T., & Adriaanse, A. (2018). Developing and testing a tool to evaluate BIM maturity: Sectoral analysis in the Dutch construction industry. *Journal of Construction Engineering and Management, 144*(8). https://doi.org/10.1061/(ASCE)CO.1943-7862.0001527.

Storm, I., Harting, J., Stronks, K., & Schuit, A. J. (2014). Measuring stages of health in all policies on a local level: The applicability of a maturity model. *Health Policy, 114*, 183–191. https://doi.org/10.1016/j.healthpol.2013.05.006.

Straub, D. W. (1989). Validating instruments in MIS research. *MIS Quarterly: Management Information Systems, 13*, 147–165. https://doi.org/10.2307/248922.

Ünal, E., & Köhler, C. (2019). Development of a quantiative evaluation tool to support the development process of industry 4.0 production equipment. In *Proceedings of the Design Society: 22nd International Conference on Engineering Design (ICED19)*. https://doi.org/10.1017/dsi.2019.215.

Valdés, G., Solar, M., Astudillo, H., Iribarren, M., Concha, G., & Visconti, M. (2011). Conception, development and implementation of an e-government maturity model in public agencies. *Government Information Quarterly, 28*, 176–187. https://doi.org/10.1016/j.giq.2010.04.007.

Warnecke, D., Wittstock, R., & Teuteberg, F. (2019). Benchmarking of European smart cities – a maturity model and web-based self-assessment tool. *Sustainability Accounting, Manag. and Policy J.l, 10*, 654–684. https://doi.org/10.1108/SAMPJ-03-2018-0057.

Wendler, R. (2012). The maturity of maturity model research: A systematic mapping study. *Information and Software Technology, 54*, 1317–1339. https://doi.org/10.1016/j.infsof.2012.07.007.

Wijayaratne, A. L., & Singh, D. (2015). Developing an academic library website model, a designer's checklist, and an evaluative instrument: A Delphi method approach. *Electronic Library, 33*, 35–51. https://doi.org/10.1108/EL-11-2012-0115.

Yang, Z., & Bai, H. (2009). Building a maturity model for college library knowledge management system. *Int. Conf. Test and Meas.*. https://doi.org/10.1109/ICTM.2009.5412987. *ICTM'09*.

Yang, Z. Y., Zhu, R. B., & Zhang, L. N. (2016). Research on the capability maturity model of digital library knowledge management. In B. Xu (Ed.), *Proceedings of the 2nd Information Technology and Mechatronics Engineering Conference* (pp. 333–337). Paris: Atlantis Press. https://doi.org/10.2991/itoec-16.2016.63.

Yung-Ming, C. (2014). Why do users intend to continue using the digital library? An integrated perspective. *Aslib Journal of Information Management, 66*, 640–662. https://doi.org/10.1108/AJIM-05-2013-0042.

Zhu, K. G., Song, X. D., & Sun, Y. P. (2016). The path and maturity model of university libraries to enhance the social network service ability. *J. Mech. Eng. Res.Develop., 39*, 239–243.

Fatemeh Sheikhshoaei is an assistant professor in medical library and information science department at the Tehran University of Medical Sciences. She received her PhD in information science and knowledge studies from Faculty of Management at the University of Tehran. Her research focuses on digital libraries, information technology application in libraries, traditional and online peer review process in scientific journals and Medical Subject Headings (MeSH). Her research has been published in journals including *Electronic Library, Webology, Library Philosophy and Practice, Journal of Scholarly Publishing, Iranian Journal of Information Processing Management,* and *Information Sciences and Technology*.

Nader Naghshineh is an associate professor in information science and knowledge studies department at the University of Tehran. He has a PhD in library and information sciences from the University of Tehran. His research areas are information literacy, digital libraries, information seeking behaviors, and information retrieval. His research has been published in journals including Electronic Library, Journal of the Canadian Health Libraries Association, Health Information and Libraries Journal, Journal of Information Technology Management, Malaysian Journal of Library and Information Science, Iranian Journal of Information Processing Management, Webology, and Journal of Evidence-Based Medicine.

Sirous Alidousti is an associate professor in the IT management department at the Iranian Research Institute for Information Science and Technology (IranDoc). He received his PhD in management from the University of Tehran. His research areas are information management, IT management, system design and strategic planning. His research has been published in journals including Iranian Journal of Information Processing Management, Journal of Information Technology Management, Information Sciences and Technology, Libri, Electronic Library, Serials Review, and Library Management.

Maryam Nakhoda is an assistant professor in information science and knowledge studies department at the University of Tehran. She earned her PhD in information science and knowledge studies from the University of Tehran. Her research interests include information seeking behavior, change management, information management, and IT management. Her research has been published in journals including Accountability in Research, Library and Information Science Research, Journal of Medical Ethics and History of Medicine, Electronic Library, Iranian Journal of Information Processing Management, Management Science Letters, Libri, and Journal of Librarianship and Information Science.

Hossein Dehdarirad is a Ph.D. Candidate in medical library and information science at the Tehran University of Medical Sciences. His research focuses on information retrieval, digital libraries, scientometrics and information systems. His research has been published in journals including Scientometrics and Data Technologies and Applications.