The Electronic Library

The factors and criteria for prioritization of GIS utilization by libraries
Roya Pournaghi Fahimeh Babalhavaeji

Article information:

Users who downloaded this article also downloaded:

For Authors

About Emerald www.emeraldinsight.com

The factors and criteria for prioritization of GIS utilization by libraries

Roya Pournaghi

Iranian Research Institute for Information Science and Technology, Tehran, Iran, and

Fahimeh Babalhavaeji

Department of Library and Information Science, Science and Research Branch, Islamic Azad University (IAU), Tehran, Iran

Abstract

Purpose – This paper aims to identify the impressive factors on choosing the type of the libraries and information centers and determining their significance and prioritizing them and finally determining the priority of each type according to the identified factors to implement geographic information system (GIS) in the library researches.

Design/methodology/approach – A combination of documentary, Delphi and analytic methods was used in the current study. Due to the interdisciplinary nature of the topic in mind, different dimensions of the issue were firstly identified through reviewing the research literature. Then, the Delphi panel was formed and the factors and indices for choosing and prioritizing the libraries were extracted and finally the analytic-hierarchy and Topsis method was used for analyzing and ranking the data which were collected through a questionnaire. In this way, the instrument was devised by the researcher and the population under the study consisted of the professors in two fields of LIS and the GIS. The criteria include the "access to the library", "being active", "the number of sources", "the size and space of the place", "the library equipment", "compatibility" each one include eight, seven, five, five, two and five factors, respectively.

Findings – In the Delphi study, six factors including 32 indices were determined for prioritizing the libraries to implement the GIS in the library researches. The analytic-hierarchy method was applied to compare the factors correspondingly in terms of the degree of their significance. In this way, "access to the library sources", "being active", "the number of sources", "the size and space of the place", "the library equipment" and "compatibility" were identified as the factors on choosing the library type with the values of 0.39, 0.24, 0.16, 0.08, 0.07 and 0.06, respectively. Then, several types of the libraries were ranked and the findings show that academic libraries are prioritized as the first one for conducting the GIS projects.

Originality/value – Employing the factors resulted from the conducted researches is recommended for choosing the libraries to implement the GIS, so that the researches in this interdisciplinary field become more organized. To extend the current study, the extracted factors and indices can be sent to the professors of the LIS from the other countries to elicit their insights and thereby, designing a standard international checklist for choosing the libraries and information centers in the GIS projects.

Keywords Libraries, Factors and criteria, Geographic information system, Library research, Prioritizing the libraries

Paper type Research paper

Introduction and statement of the problem

Geographic information systems (GISs) originally emerged to contribute to geography. Eratosthenes, the chief librarian of the Eskandariyeh museum (192-234 B.C.), coined the term "geography" (Martin, 2005). Tomlinson (1998) coined the term "GIS" in the early 1960s to refer to computer programs that operate by means of geographical and geospatial data (Wade and Sommer, 2006). As more and more GIS researchers applied these programs as a tool in their research, a wide range of scientific questions, methods and GIS-related knowledge was generated (Goodchild, 1992). Waters (2003) originally introduced the term "GIS" into the *Encyclopedia of the Library and Information Sciences*. Franklin (1992, p. 12) defined GIS briefly as "a computer system designed for collecting, storing, retrieving, processing and displaying geospatial data".

As the definitions might imply, the GISs rely on geospatial data. The areas in which the GIS can be applied are as follows: resource management, land use planning, defence, welfare services, environmental purification, demographic analysis, marketing, spatial evaluation, effects of sales and competition, prediction, re-processing, media planning and exploitation, customer satisfaction and warehouse control and financial management (Coyle, 2011).

GIS applications are rapidly expanding; thus, presenting a comprehensive view is difficult. In this sense, GIS has provided a plethora of opportunities for its various applications in different fields. It has also made an impact on the field of library and information sciences (LIS) in different ways. A recent review of the existing related literature by Michalec and Welsh (2007) showed that the number of the LIS articles related to the GIS or geospatial data are increasing. They made use of these two terms to find full-text articles in the Library, Information Science, and Technology Abstracts (LISTA) database and found 146 articles. This study provided an overview regarding the study of the article publication patterns in LIS which included the two aforementioned terms. Even a number of texts have been published considering the GIS implementation in libraries, per Donnelly (2010) and Abresch *et al.* (2008). In academic libraries, in addition to traditional printed planography sources, geographical libraries collect, publish and use geographical data (Weimer and Reehling, 2006). In response to the growing demand from the GIS librarians, the American Libraries Association's Map and Geography Education Committee Round Table (MAGERT) developed a set of major criteria for this type of information professional (Weimer and Reehling, 2006).

Xia (2004a) conceived the benefits of the GIS in LIS studies as an underlying reason for its application. These benefits include the provided maps which present more information than mere table and texts in general, and allow librarians to analyse the library's services in particular. Transferring GIS software from the central processing computers to PCs has led to a considerable decrease in expenditures and easier access to the market. More developments in the applicability of this type of system have made it accessible for use by librarians (Donnelly, 2010). The application of the GIS in LIS studies is gradually developing. A review by Bishop and Mandel (2010) demonstrated the development of the application of the GISs in library research.

GIS has various innovative applications in managing libraries and information centres including: the libraries interior space; designing libraries and information centres; collection building (selecting books); site selection; building a new library; predicting the survey location (locating libraries in the coming years); organizing documents and map databases; providing geographical catalogues for books, archives

and online library guides; library services marketing; and numerous other potential and real applications.

GISs have been introduced as a tool for displaying the data of the LIS studies graphically. These data can serve as the demographic information of library users which are employed for easier library design (Adkins and Sturges, 2004; Hertel and Sprague, 2007; Preiser and Wang, 2006). In addition, they can include the data which are used in the interior space of the library (Xia, 2004a, 2004b, 2005).

As the literature suggests, the growing use of this system is obvious in the analysis and management of libraries and information centre activities. Hence, utilizing this system is recommended to libraries and it is well worth expending the necessary time, energy, expenditures and human resources. GIS technology is efficient and economical for managing facilities, and useful for analysing the geospatial data for the library. To this end, the main interest of the current study was identifying and ranking the factors for choosing libraries and information centres and, consequently, prioritizing several types of libraries to implement the GISs from the viewpoint of experts and professors in both fields of geography and LIS. These criteria would hopefully contribute to choosing more appropriate libraries to implement the GIS and geospatial data analysis. It might also lead to more efficient and optimal use and management of this system in libraries. The present study did not concern itself with implementing GIS in any type of library, but instead prioritization was used to clarify the importance of different libraries for utilizing it. In this way, those libraries which it would be worth spending time, energy and expenditure are identified with regard to utilizing the GIS in interior-space library studies.

Literature review

With regard to the GIS applications in libraries, a variety of writings have been done since 1992. Several studies have been conducted since 2005 which are briefly reviewed below, literature prior to 2004 was not reviewed. Xia (2005) investigated the use of study spaces in MacKimmie Library at Calgary University which aimed at evaluating the sources and facilities of the reading hall through applying the GIS. It was revealed that the MacKimmie library users intended to use the private spaces and individual desks more. Similarly, DeVoe (2006) and Molyneux (2006) discussed the potential of the GIS for developing the collection according to maps of the library areas. In another study at Yale University, Parrish (2006) pointed out that the GIS, along with other services of the library reference, would lead to a significant decrease in the time spent by users and an increase in the efficiency and effectiveness of them. Colorado State Library (2006) succeeded in conducting a wide range of projects using the GIS. In this state, the network and sharing of the Colorado State Library with the other public libraries were used to design GIS mapping projects which represented the library users' distribution related to geographical features. Moreover, several local services can be presented by allocating codes to the library users' addresses through the GIS. This enhanced the efficiency of the library branches and it is widely used (Preiser and Wang, 2006). In another study by Hertel and Sprague (2007), they used demographic information to plan the building of new libraries. Sedighi (2008) used all the existing data including Persian and English theses, conference articles, journal articles, reports and so forth, which have already been organized and sorted out. In this study, users were able to see the descriptive information of the documents and receive a map of the region under the study by

clicking on the pertinent barcode. Gaus *et al.* (2008) used the GIS to analyse the library branches which were serving immigrants and the effectiveness of their services on the library branches in Ghent, Belgium.

Several recent studies have argued for utilizing the GIS and its modern technology to describe the library users by their demographic information to allocate appropriate sources and services to them (Public Libraries, 2004; Advanced Technology Libraries, 2005; Futterman, 2008). Bishop (2008) investigated the distance between the libraries in a specific region through the GIS to market library services and calculated that it took a longer time for patrons to get to one of the library branches. It was also shown that the library branches in that region did not have an appropriate distribution. Similarly, Venuda (2005a, 2005b) and Franqueville (2000) discussed the advantages of GIS as a tool for marketing. Koontz *et al.* (2009) investigated the underlying reasons for closing some of the public libraries services. They analysed and compared the geographical regions around the public libraries demographically and socio-economically, and found that a number of factors caused the libraries' closure, including: not using them, decreases in the budget, an increase in poverty and a growing decrease in the number of local educated users, which all led to lowering the library facilities and services, and closing some services for potential users. The results of another study revealed that some users made use of the library services virtually (Mon *et al.*, 2009). These maps were depicted using their Internet Protocol addresses, e-mail services and online chatting.

Mandel (2010a) also used the GIS in intra-library research. He maintained that researchers in the field of LIS can apply it for analysing and displaying library data: for example, the seats where the users sit, read, gather and use other facilities of the library. In another study, Mandel (2010b) analysed the users' entrance to public libraries in general and the users' entrance to a public library in South Florida in particular, through the GIS. In this way, the map included the frequency of use for most pathways to the library entrance. Park (2011) obtained a better understanding of users' trips to libraries, activities, demographic statistics and other factors which would influence access to the library. By analysing people's daily trips, the study provided a model of the patterns and, thus, some solutions for user access to the library. Moreover, Park (2012) made an attempt to develop a new tool for measuring trips which would allow for measuring the distance and length of the trips precisely.

Sedighi (2012) dealt with the application of the GIS as a supportive decision-making tool in analysing geospatial data of database usage in an academic library. The results demonstrated that databases should be prepared to answer proposed questions by users through the functions of analysing the system, as well as a variety of other applied and logical programs. The obtained results would be extremely valuable for decision-making and planning in the libraries of academic and research centres.

Purposes of research

- Identify the factors determining library type for the GISs utilization.
- Determining the extent of significance and prioritizing the factors which make an impact on choosing the type of libraries and information centres to implement the GIS system in various libraries.
- Identify the library types in relation to the determining factors according to priority.

Research questions

RQ1. What are the factors for determining the library type for the GIS utilization?

RQ2. To what extent are the determined factors used for choosing the library types for the GIS utilization?

RQ3. Which library type is more preferred for the GIS utilization: public, academic, institutional, professional, special or children's library?

Methodology

A combination of documentary, Delphi, and analytical methods were used in the current study. Bearing the interdisciplinary nature of the topic in mind, different dimensions of the issue were, firstly, identified through literature review. After studying the texts, the researchers extracted 32 factors. Then, the Delphi technique was used to confirm and finalize the factors for choosing the library. A Delphi panel was conducted among the librarian and GIS experts. They were faculty members and others who had sufficient experience with GIS. The criteria were sent to them two times. The second time, they were asked to answer according to the average of the other colleagues' answers. The extracted factors were classified into six criteria through designing the questionnaire in two two-way stages. Table I displays the texts used for the tentative choosing of the factors and criteria. Table II illustrates the answer to the first research question "What are the factors on choosing the library type and information science centres in order to implement geographic information systems?" As it can be seen, "access to the sources", "being active", "number of sources", "size and space of the place", "library equipment" and "compatibility" criteria include eight, seven, five, five, two and five factors, respectively. Five library types were recommended by the Delphi panel members and they prioritized the library types for the GIS utilization.

After finalizing the six criteria, a 16-item questionnaire was sent to members. After data collection, the data were analysed by means of the hierarchy-process and Topsis methods.

Sources	Criteria
Xia (2004c), Derfert-Wolf *et al.* (2005), Xia (2005), Miller (2008), Babalhavaejil *et al.* (2009), Mandel (2010a)	Access to the sources
Hawkins (1994), Derfert-Wolf *et al.* (2005), Xia (2005), Preiser and Wang (2006), Babalhavaejil *et al.* (2009)	Being active
Fussler and Simon (1969), Xia (2004a), Derfert-Wolf *et al.* (2005), Babalhavaejil *et al.* (2009)	Sources
ARCL (1995), Padilla (2002), Derfert-Wolf *et al.* (2005), Xia (2004b), Miller (2008), Sannwald and Smith (2008), Babalhavaejil *et al.* (2009), Mandel (2010a,b), Barclay and Scott (2012)	Size and space of the place
Xia (2004b), Sannwald and Smith (2008), Babalhavaejil *et al.* (2009)	Equipment
ALA (2001), Padilla (2002), Derfert-Wolf *et al.* (2005), Preiser and Wang (2006), Sannwald and Smith (2008), Koontz *et al.* (2009), Landgraf (2012)	Compatibility

Table I.
The sources used to determine the criteria and factors

Factor	Criterion
To have reference services (librarian)	Access to the sources
To have a guideline in electronic form	
The access system to the collection should be open	
To have analytical-descriptive catalogue for electronic sources	
To have analytical-descriptive catalogue for printed sources	
To have analytical-descriptive catalogue for audio-visual sources	
To have appropriate classification system	
To have a guide in the traditional form	
Presenting various services	Being active
Appropriate notification for services	
The number of clients per a day	
The type of clients	
The library daily working schedule	
The number of members	
The number of staff	
To have Internet access and databases	Sources
The number of periodicals	
The total number of books	
The total number of other materials and sources	
The total number of the particular sources	
To have different sections in the library	Size and space of the place
The general condition of the library hall and building	
The total area in m^2	
To have a reading hall	
Predicting the space for future development of the library	
Standard design in setting the equipment, shelves and the way pathways are configured in the library	Equipment
Different types of facilities and equipment	
Fundamental support including drinking water, air conditioning, light and electricity, soundproof	Compatibility
Welfare services	
The internal and external attractiveness of the library	
Security and safety standards	
Environmental and hygienic condition	

Table II.
The determined
criteria and factors

Findings

This section presents the findings obtained from the hierarchy-process and Topsis data analysis for prioritizing the libraries based on six determined criteria. The answer to the research questions are provided in the current tables. According to Table III, the data in vertical and horizontal columns are the same (it is a matrix). The criteria have been paired in one point – the results of paired comparison of the criteria are normalized in Table IV.

Following the collection of the questionnaires and feeding the data into an Excel spreadsheet, the relative weight of all six criteria were calculated based on the matrix in Table III.

After determining the data matrix, normalizing the data was done. Table IV illustrates the results. To ensure normalizing, the number of each cell was divided into the total number of each column.

Table IV shows the total of each matrix row was calculated and the final weight of the criteria was obtained for the responses to the second research question, "To what extent are the determined factors used for choosing the library types for GIS utilization?". In this way, the effective criteria on choosing the library were identified as access to the library, being active and number of the sources, size and space of the place, library equipment and compatibility with values of 0.39, 0.24, 0.16, 0.08, 0.07 and 0.06, respectively.

To prioritize the libraries for implementing the GIS services, the data elicited through the questionnaire, item number six, were used in which the experts were asked to give five types of libraries including public, academic, special, children's and institutional, a score between 1 and 20 in terms of the six aforementioned criteria. Here, the results are presented based on the Topsis technique. The Topsis method was proposed by Hwang and Yoon (1981) in 1981. It is based on the concept that the chosen option (or alternative) should be the closest one to the ideal positive solution and the farthest one to the ideal negative solution. In this method, m number of options (or alternatives) is evaluated by means of n number of criteria and each problem can be considered as a geometrical system including n number of dots in an n-dimensional space.

In this method, the decision-making matrix is evaluated including m number of options (or alternatives) and n number of indices. In Table V, the decision-making matrix includes five options (or alternatives) and six indices (criteria). The value of each cell was obtained through calculating the given scores by 15 professors and experts.

In this method, the decision-making matrix is evaluated which include **m** options (or alternatives) and **n** indices. Then, the following formula was used:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^{2}}}$$

In this formula, **Xij** has a numeric value obtained from **I** option or is itself as **J** indices. In this step, the present scale has become non-scaled in the decision matrix

Compatibility	Equipment	Size and space of the library	No. of sources	Being active	Access to the sources	Criteria (indices)
3.23	3.98	**4.50**	4.21	4.36	1.00	Access to the sources
3.17	**4.18**	4.17	3.77	1.00	0.23	Being active
2.56	3.42	**4.27**	1.00	0.26	0.24	Number of sources
1.54	**2.11**	1.00	0.23	0.24	0.22	Size and space of the library
2.31	1.00	0.47	0.29	0.24	0.25	Equipment
1.00	0.43	0.65	0.39	0.32	0.31	Compatibility

Notes: Table III shows that size and space of the library has the most role (4.50) in access to the sources, equipment (4.18) in criteria of being active and similarly in size and space the library (2.11). Equipment has also the most role in the equipment and compatibility (indices)

Table III.
The results of paired comparisons of the criteria

Normalized final weight for all factors	Total weight for all factors	Compatibility	Equipment	Size and space of the library	No. of sources	Being active	Access to the sources	Criteria (indices)
0.39	2.34	1.40	1.58	1.79	2.55	4.07	2.67	Criteria (indices)
0.24	1.42	1.38	1.66	1.66	2.29	0.94	0.61	Criteria (indices)
0.16	0.94	1.11	1.36	1.70	0.61	0.25	0.63	Criteria (indices)
0.08	0.48	0.67	0.84	0.40	0.14	0.22	0.59	Criteria (indices)
0.07	0.44	1.01	0.40	0.19	0.18	0.22	0.67	Criteria (indices)
0.06	0.37	0.43	0.17	0.26	0.24	0.30	0.83	Criteria (indices)
1	6	6	6	6	6	6	6	Total

Table IV.
The results for normalized matrix and the weight of each criterion

through division of each one of the values to the size of vector which is related to the same scale. The decision-making matrix was normalized and the results are presented in Table VI.

Then, the weight of each index was calculated (see Table VII) considering the results of hierarchy analysis in the matrix of Table VI.

After weighing matrix and multiplying it by normalized decision-making matrix, the criterion matrix was obtained (see Table VIII). Five library types recommended to the Delphi panel members, as seen below, were prioritized for the GIS utilization and they chose the academic library.

Then, the positive and negative ideal options (or alternatives) were selected through the following formula:

Compatibility	Equipment	Size and space of the place	No. of sources	Being active	Access to the sources	Indices/options (or alternatives)
14.4	13.0	14.3	13.9	15.4	14.5	Public library
16.4	16.6	15.5	17.4	17.1	17.3	Academic library
15.0	14.1	13.1	13.4	14.8	14.9	Children's library
14.5	13.2	14.5	14.0	15.5	14.6	Special library
14.9	13.7	14.8	14.3	15.3	14.9	Institutional library

Table V.
Decision-making matrix

Compatibility	Equipment	Size and space of the place	No. of sources	Being active	Access to the sources	Indices/options (or alternatives)
0.4285	0.4098	0.4419	0.4226	0.4406	0.4259	Public library
0.4857	0.5233	0.4811	0.5303	0.4882	0.5060	Academic library
0.4454	0.4436	0.4047	0.4084	0.4234	0.4357	Children's library
0.4301	0.4175	0.4478	0.4280	0.4430	0.4272	Special library
0.4439	0.4327	0.4570	0.4362	0.4382	0.4362	Institutional library

Table VI.
Normalized decision-making matrix

Compatibility	Equipment	Size and space of the place	No. of sources	Being active	Access to the sources	Indices/options (or alternatives)
0.00	0.00	0.00	0.00	0.00	0.39	Access to the sources
0.00	0.00	0.00	0.00	0.24	0.00	Being active
0.00	0.00	0.00	0.16	0.00	0.00	Number of sources
0.00	0.00	0.08	0.00	0.00	0.00	Size and space of the place
0.00	0.07	0.00	0.00	0.00	0.00	Equipment
0.06	0.00	0.00	0.00	0.00	0.00	Compatibility

Table VII.
Weighing matrix

$$\text{Positive ideal option } A^* = \left\{ \left(\max_i v_{ij} | j \in J \right), \left(\min_i v_{ij} | j \in J' \right) | i = 1, 2, \dots, m \right\}$$
$$= \{ v_1^*, v_2^*, \dots, v_j^* \dots, v_n^* \}$$
$$\text{Negative ideal option } A^- = \left\{ \left(\min_i v_{ij} | j \in J \right), \left(\max_i v_{ij} | j \in J' \right) | i = 1, 2, \dots, m \right\}$$
$$= \{ v_1^-, v_2^-, \dots, v_j^- \dots, v_n^- \}$$

Indeed, two made virtual options are the best and worst solutions. In the above formula, the V matrix is a balanced non-scaled and the **Js** are the scales. In the next step, the interval between each n-dimensional positive and negative ideal option (or alternative) was calculated through Euclidean interval calculation method:

$$S_{i*} = \sqrt{ \sum_{j=1}^{n} (v_{ij} - v_j^*)^2 } \quad i = 1, 2, 3, \cdots, m$$

$$S_{i-} = \sqrt{ \sum_{j=1}^{n} (v_{ij} - v_j^-)^2 } \quad i = 1, 2, 3, \cdots, m$$

The calculated interval for each option (or alternative) (library) through positive and negative solutions are presented in Table IX.

The proximity extent to the ideal solution was calculated through the following formula:

Compatibility	Equipment	Size and space of the place	No. of sources	Being active	Access to the sources	Indices/options (or alternatives)
0.026	0.030	0.035	0.066	0.104	0.166	Public library
0.030	0.039	0.038	0.083	0.116	0.198	Academic library
0.027	0.033	0.032	0.064	0.100	0.170	Children's library
0.027	0.031	0.036	0.067	0.105	0.167	Special library
0.027	0.032	0.036	0.069	0.104	0.170	Institutional library

Table VIII.
Criterion selection matrix

The interval from the negative ideal solution		The interval from the positive ideal solution		Options (or alternatives)
0.0059	S1-	0.0388	S1[a]	Public library
0.0419	S2-	0.0007	S2[a]	Academic library
0.0053	S3-	0.0381	S3[a]	Children's library
0.0071	S4-	0.0377	S4[a]	Special library
0.0089	S5-	0.0343	S5[a]	Institutional library

Note: [a] positive ideal option

Table IX.
The results of calculating the interval from the positive and negative ideal options (or alternatives)

$$C_{i*} = \frac{S_{i-}}{\sqrt{S_{i*} + S_{i-}}}$$

According to the above formula, academic libraries were ranked as the first one in terms of the aforementioned criteria. The result of calculation for academic library was ($C2 = 0.9841$), institutional library ($C5 = 0.2065$), special library ($C4 = 0.1585$), public library ($C1 = 0.1328$) and children's library ($C3 = 0.1224$).

This result is a response to the third research question, "Which library type is more preferred for implementing geographic information systems: public, academic, institutional, professional, special, or children's library?", the findings indicated that the academic library was ranked as the first one for implementing the GIS with institutional, special, public and children's libraries ranked to the lowest, respectively.

Discussion and conclusion
The research findings revealed six criteria for prioritizing the libraries to utilize GIS in library research which are ranked in terms of their significance as follows: access to the library, being active and number of sources, size and space of the place, library equipment and compatibility. Accordingly, academic, institutional, special, public and children's libraries were ranked from high to low, respectively, for implementing and utilizing the GISs in library research.

Making use of the GIS technology in library research is developing. A recent review study demonstrated that these applications are increasing (Bishop and Mandel, 2010). Despite the large number of published articles in this discipline, no study has been conducted to identify and rank the criteria for choosing appropriate libraries for conducting GIS projects and for prioritizing the libraries in terms of these factors. However, some attempts have been made to reveal some relevant aspects. For instance, Dehghani-Sanig and Mahmoodi (2011) strived to identify and rank the criteria for selecting libraries.

Lots of studies have been conducted considering the GIS applications in libraries; nonetheless, they mostly pointed to the potential of the GIS application in libraries and evaluation of library services, but did not touch upon the issue of choosing appropriate libraries for utilizing the GIS. Based on the findings of this research, the relevant indices and factors are implied in the reported studies (for example, see Donnelly, 2010). However, no study has been conducted or reported regarding the optimal utilization of GIS in library research through identifying all these factors and indices, and eliciting experts' insights in considering ranking and prioritizing the libraries. The researchers hope that the current study will be the starting point for utilizing the GIS technology in the libraries in Iran and will contribute to selecting which libraries to start with when conducting the GIS projects in LIS research all over the world.

Nowadays, due to a lack of more precise sources, the prioritization from the current study might be applied for implementing the GIS. Moreover, the determined indices and factors can be applied to prioritizing several libraries of different types according to their weight. Nevertheless, this method should be applied taking the experts from both fields of the LIS and geography into account. It should also be considered that utilizing this technology in the field of LIS has recently begun in Iran. Hence, there might be slight differences among the insights of Iranian experts

and those of other countries with regard to the growth, development and application of the GIS. Nonetheless, this issue would, by no means, challenge the validity of the results of the current study. Contrarily, it highlights the significance of doing further research.

Suggestions for further research

For completion of the current study, it is recommended to extract indices and factors from the current study to send them to professors in other countries, particularly those who have been using this technology in libraries for more than two decades to gather their insights for designing a standard international checklist for choosing libraries and information centres to determine research preferences for the GIS projects. Such a checklist would hopefully give rise to a plethora of studies all around the world and research in the field would become more organized. The possibility of distributing the designed questionnaire to more LIS experts to obtain more data to analyse is highly recommended.

References

Abresch, J., Hanson, A., Heron, S.J. and Reehling, P.J. (2008), *Integrating Geographic Information Systems into Library Services: A Guide for Academic Libraries*, Information Science Publication, Hershey, PA.

Adkins, D. and Sturges, D.K. (2004), "Library service planning with GIS and census data", *Public Libraries*, Vol. 43 No. 3, pp. 165-170.

Advanced Technology Libraries (2005), "Civic technologies announces new service", *Advanced Technology Libraries*, Vol. 34 No. 5, pp. 8-9.

American Libraries Association (ALA) (2001), "Library services for people with disabilities policy", available at: www.ala.org/ascla/asclaissues/libraryservices (accessed 16 January 2013).

Association of College and Research Libraries (ARCL) (1995), "Standards for college libraries: 1995 edition", *College & Research Libraries News*, Vol. 55 No. 3, pp. 261-272, 294.

Babalhavaejil, F., Isfandyari-Moghaddam, A., Aqili, V. and Shakooii, A. (2009), "Quality assessment of academic library performance: the case of an Iranian academic library", *Malaysian Journal of Library & Information Science*, Vol. 14 No. 2, pp. 51-81.

Barclay, D.A. and Scott, E.D. (2012), "Directions to library wayfinding: directional and informational signs guide patrons into and around the library", available at: http://americanlibrariesmagazine.org/features/03202012/directions-library-wayfinding (accessed 5 April 2012).

Bishop, B.W. (2008), "Use of geographic information systems in marketing and facility site location", *Public Libraries*, Vol. 47 No. 5, pp. 65-69.

Bishop, B.W. and Mandel, L.H. (2010), "Utilizing geographic information systems (GIS) in library research", *Library Hi Tech*, Vol. 28 No. 4, pp. 536-547.

Colorado State Library (2006), "Arc news online, CO state library conducts a variety of projects with GIS", available at: www.esri.com/news/arcnews/summer06articles/colorado-state.html (accessed 23 August 2012).

Coyle, A. (2011), "Interior library GIS", *Library Hi Tech*, Vol. 29 No. 3, pp. 529-549.

Dehghani-Sanig, J. and Mahmoodi, H. (2011), "Identification and ranking of criteria affecting the allocation of public libraries using fuzzy ANP and fuzzy TOPSIS", *Journal of Library and Information Science*, Vol. 53 No. 1, pp. 319-326.

Derfert-Wolf, L., Gorski, M. and Marcinek, M. (2005), "Quality of academic libraries funding bodies", *Librarians and Users Perspective, Czerwiec*, Vol. 9.

DeVoe, K. (2006), "Developing a predictive model of library collection use", *Against the Grain*, Vol. 18 No. 1, p. 63.

Donnelly, F.P. (2010), "Evaluating open source GIS for libraries", *Library Hi Tech*, Vol. 28 No. 1, pp. 131-151.

Franklin, C. (1992), "An introduction to geographic information systems: linking maps to databases", *Database,*, Vol. 15 No. 2, pp. 13-21.

Franqueville, P. (2000), "The new tools of urbanism at the service of prospective librarianship", *Bulletin des Bibliothèques de France*, Vol. 45 No. 3, pp. 97-104.

Fussler, H.H. and Simon, J.L. (1969), *Patterns in the Use of Books in Large Research Libraries*, University of Chicago Press, Chicago, IL.

Futterman, M. (2008), "Finding the underserved", *Library Journal*, Vol. 133 No. 17, pp. 42-45.

Gaus, D., Velter, J. and Verhasselt, E. (2008), "Ook de plaats is een waarheid", *Bibliotheek-en Archiefgids*, Vol. 84 No. 2, pp. 10-19.

Goodchild, M.F. (1992), "Geographic information science", *International Journal of Geographical Information Systems*, Vol. 6 No. 1, pp. 31-45.

Hawkins, A.M. (1994), "Geographical Information Systems (GIS): their use as decision support tools in public libraries and the integration of GIS with other computer technology", *New Library World*, Vol. 95 No. 1117, pp. 4-13.

Hertel, K. and Sprague, N. (2007), "GIS and census data: tools for library planning", *Library Hi Tech*, Vol. 25 No. 2, pp. 246-259.

Hwang, C.L. and Yoon, K. (1981), *Multiple Attribute Decision Making: Methods and Applications, A State of the Art Survey*, Springer-Verlag, New York, NY.

Koontz, C.M., Jue, D.K. and Bishop, B.W. (2009), "Public library facility closure: an investigation of reasons for closure and effects on geographic market areas", *Library & Information Science Research*, Vol. 31 No. 2, pp. 84-91.

Landgraf, G. (2012), "American Libraries' annual review of the best in new and renovated library facilities: library design showcase", available at: www.americanlibrariesmagazine.org/librarydesign12 (accessed 12 December 2012).

Mandel, L.H. (2010a), "Geographic information systems: tools for displaying in-library use data", *Information Technology & Libraries*, Vol. 29 No. 1, pp. 47-52.

Mandel, L.H. (2010b), "Toward an understanding of library patron way finding: observing patrons' entry routes in a public library", *Library & Information Science Research*, Vol. 32 No. 2, pp. 116-130.

Martin, G.J. (2005), *All Possible Worlds: A History of Geographical Ideas*, Oxford University Press, New York, NY.

Michalec, M. and Welsh, T.S. (2007), "Quantity and authorship of GIS articles in library and information science literature, 1990-2005", *Science & Technology Libraries*, Vol. 27 No. 3, pp. 65-77.

Miller, K.F. (2008), *Service Quality in Academic Libraries: An Analysis of LibQUAL+™ Scores and Institutional Characteristic*, Kathleen F. Miller, Orlando, FL.

Molyneux, B. (2006), "Predicting high-circulating titles for public libraries", *Against the Grain*, Vol. 18 No. 3, pp. 92-93.

Mon, L., Bishop, B.W., McClure, C.R., McGilvray, J., Most, L., Milas, T.P. and Snead, J.T. (2009), "The geography of virtual questioning", *Library Quarterly*, Vol. 79 No. 4, pp. 393-420.

Padilla, L. (2002), "Site selection for libraries: American institute of architects", available at: http://libris.oshea.net/docs/SiteSelectionLibraries.pdf

Park, S.J. (2011), "The physical accessibility of public libraries to users: a GIS study", *PhD Dissertation*, FL State University, Tallahassee, FL.

Park, S.J. (2012), "Measuring travel time and distance in library use", *Library Hi Tech*, Vol. 30 No. 1, pp. 151-169.

Parrish, A. (2006), "Improving GIS consultations: a case study at Yale University Library", *Library Trends*, Vol. 55 No. 2, pp. 327-339.

Preiser, W.F.E. and Wang, X. (2006), "Assessing library performance with GIS and building evaluation methods", *New Library World*, Vol. 107 No. 5, pp. 193-217.

Public Libraries (2004), "Civic Technologies announces new library decision maps on demand GIS service for smaller public libraries", *Public Libraries*, Vol. 43 No. 6, p. 365.

Sannwald, W.W. and Smith, R.S. (2008), *Checklist of Library Building Design Considerations*, Library Administration and Management Association Division of the American Library Association, Chicago, IL.

Sedighi, M. (2008), "Use of Geographical Information System (GIS) in the cataloging of documents: a case study of earthquake documents collections", *Library Hi Tech*, Vol. 26 No. 3, pp. 454-465.

Sedighi, M. (2012), "Application of geographic information system (GIS) in analyzing geospatial information of academic library databases", *The Electronic Library*, Vol. 30 No. 3, pp. 367-376.

Tomlinson, R. (1998), "The Canada geographic information system", in Foresman, T.W. (Ed.), *The History of Geographic Information Systems: Perspectives from the Pioneers*, Prentice-Hall, Upper Saddle River, NJ, pp. 21-32.

Venuda, F. (2005a), "GIS (geographic information system) in bibliotheca: prima parte", *Bulletin AIB*, Vol. 45 No. 3, pp. 327-345.

Venuda, F. (2005b), "GIS (geographic information system) in bibliotheca (second parte)", *Bulletin AIB*, Vol. 45 No. 4, pp. 477-488.

Wade, T. and Sommer, S. (2006), *A to Z GIS: An Illustrated Dictionary of Geographic Information Systems*, ESRI Press, Redlands, CA.

Waters, N. (2003), "Geographic information systems", *Encyclopedia of Library and Information Science*, Taylor & Francis, London, pp. 1106-1114.

Weimer, K.H. and Reehling, P. (2006), "A new model of geographic information librarianship: description, curriculum, and program proposal", *Journal of Education for Library and Information Science*, Vol. 47 No. 4, pp. 291-302.

Xia, J. (2004a), "GIS in the management of library pick-up books", *Library Hi Tech*, Vol. 22 No. 2, pp. 209-216.

Xia, J. (2004b), "Library space management: a GIS proposal", *Library Hi Tech*, Vol. 22 No. 4, pp. 375-382.

Xia, J. (2004c), "Using GIS to measure in-library book-use behavior", *Information Technology & Libraries*, Vol. 23 No. 4, pp. 184-191.

Xia, J. (2005), "Locating library items by GIS technology", *Collection Management*, Vol. 30 No. 1, pp. 63-72.

Further reading

Lee, S. (2007), "Mapping service areas at the Huntsville-Madison County Public Library", *Public Library Quarterly*, Vol. 26 No. 1, p. 117.

About the authors

Roya Pournaghi is an Assistant Professor in Iranian Research Institute for Information Science and Technology, Tehran, Iran and a member of Young Researchers and Elites Club of Islamic Azad University. She has a PhD in library and information science from Islamic Azad University, Science and Research Branch, Tehran, Iran and MA in Library and Information Science from Islamic Azad University, North Branch, Tehran, Iran and she has a BSc in Medical Library and Information Science from Iran University of Medical Science. She worked as a reference librarian and an expert on information services in Iran University of Medical Science from 2005-2011. She Teaches in Different Universities. Her research interests include applying GIS in libraries, IT and Research Strategies, E-learning, Education, Information Literacy, new Technologies and interaction of end Users with web-based search tools. Roya Pournaghi is the corresponding author and can be contacted at: royapoornaghe@gmail.com

Fahimeh Babalhavaeji is a Faculty Member of Islamic Azad University, Associate Professor, Head of the Library and information sciences department, faculty of Humanities and Social Sciences, Islamic Azad University, Science and Research Branch, Tehran, Iran (Date of birth: August 3, 1956, Place of Birth: Tehran, Iran, Marital Status: Married). Her teaching units include: Database Management, Economics of Information, Information Storage & Retrieval, Independent study, Indexing and Abstracting, Library management and Administration, Information Storage & Retrieval, and her research interests include: Database management, Economics of Information, Economics of publication, knowledge management, Entrepreneurships in libraries and information sciences, Information Storage & Retrieval, Content analysis, Children literature, information literacy. She has published 11 Articles in English and 30 Articles and 6 books in Persian.