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Abstract:

This study aims to describe the fundamentals of Geographic Information Systems (GIS) technology, to look into the purpose of application of Geographic Information Systems (GIS) in the context of the library and collected data about spatial information resources and services offer by the Dornsife School of Public Health Library, Drexel University. The study also discusses challenges and solutions about the implementation of GIS in the Indian library scenario. The application of GIS to provide spatial information services requires a long term strategic plan, investment and skilled personnel in the library scenario.

Keywords: GIS, Geospatial information, Location details, Geographic Information Systems, Library services.

Introduction

In the information age, due to the emergence of ICT, the rapid growth of networked services and omnipresence of the internet have changed the role, functioning pattern and duties of library and knowledge professionals. The emergence of advanced technologies including GIS transformed information searching, processing, storing, dissemination and retrieval pattern of library stakeholders as well. Historically cataloguing of spatial data in a digital format started in 1990, Canadian Library Association and Ottawa based Board issued Geomatic Data Sets, Cataloguing Rules in 1994.(Adler & Larsgaard, 2002).The present study aims to demonstrate the role, challenges, utilization and impact of GIS in the LIS scenario. In the beginning, GIS used to answer queries about 'what' is available in the library and most importantly 'where', it served to map library collection in terms of subjects organized on various floors in the multistory library building. So to retrieve a particular document from shelves would not be a time-consuming and complex process for users who has even no awareness about technical knowledge of book call numbers. GIS also used to handle cartographic or geo-referenced data in providing information services in the map library. However "GIS Librarians have a collaborative role (not currently being fully realized) to ensure that the principles and expertise of library science be present in the fast-evolving geoinformatics and spatial literacy movements."(Weimer, , Andrew & Hughes, 2008)

In US public and academic libraries using GIS and maintain Tiger files containing such information from the government that serves as a Decision Support System to answer queries about demographic characteristics of patrons, opening a branch of the library in a particular area, geography-based analytics, and after studying all probabilities librarian/researchers/academicians provides the data in or against favor in a given situation.

Significance of the study:

Physical accessibility to libraries and library materials are crucial factors, the use of GIS would help to study geography-related factors, assists in mapping and helps improve library and information service scenarios. If we glance at the worldwide scenario of libraries, all types of libraries are performing a dual role- users and providers of GIS to support research, academics and to provide effective access to spatial information worldwide. Many public and academic libraries of abroad provide GIS based services to users. The findings of this study would help to understand basics of GIS, advantages and and core areas of application of GIS in the libraries from the case study, the study particularly describes a case study of GIS services of an academic library of Drexel University and surveyed utilization of GIS based library and information services scenario globally. The challenges about the implementation of GIS in the Indian library scenario also indicated in the study.

Research Methodology:

The Case study method is used to examine the utilization of GIS technology in the library and information centers. The structured questionnaire is used as a tool to collect data regarding GIS based library and the information services of Drexel University Libraries, the website Drexel University Libraries also observed to gather relevant data about information of Drexel University, information of GIS tools and spatial data services. The literature review method is adopted to study a few pertinent examples of application and utilization of GIS in the library scenario.

Objectives of the Study

1. To demonstrate the areas of applications of GIS technology in the context of libraries, with special emphasize upon case study of Drexel University libraries.
2. To create awareness about the application of GIS technology amongst the LIS and IT professionals.
3. To examine the utilization of GIS products and services in the library scenario.
4. To identify skills/competencies required to apply GIS in the libraries.
5. To indicate challenges associated with the implementation of GIS in the Indian library scenario.

Basic concept, history, evolution and definition of GIS Technology

In the early 1960s, the leader of Canadian Geographic Information System Roger Tomlinson (born in 1933, also popularly known as Father of GIS) had invented the term 'Geographic Information System'. GIS has emerged from cartography, geography, remote sensing, CAD and photogrammetry. The contribution of GPS (Global Positioning System) is responsible remarkably for the evolution of GIS. "GIS is the only technology that actually integrates many different subjects using geography as its common framework." as stated by the environmental scientist and founder of ESRI Jack Dangermond. It is a type of Decision Support System (DSS) basically, GIS is an organized collection of hardware, network, software, data, procedures and GIS experts. In simple terminology,

computer application performing functions of capturing, processing and analyzing geospatial data is known as GIS.

GIS deals with two types of data: Spatial data which also referred to as geographic co-ordinate data (records point, line, area), while the concept of spatial thinking involves spatial influences, spatial comparison, regions, spatial patterns, spatial hierarchies, spatial associations, analogies, sequences and transitions. (Romund, G, 2019).

Secondly, it deals with attribute data, information associated with specific geographic characteristics are captured, processed and displayed in the visual form or map format.

Dueker (1979) had defined GIS as "A special case of information systems where the database consists of observations on spatially distributed features, activities, or events, which are definable in space as points, lines, or areas. A GIS manipulates data about these points, lines and areas to retrieve data for ad-hoc queries and analyses."

Parker (1988) explained GIS as "An information technology which stores, analyses, and displays both spatial and non-spatial data."

Normally library databases consist of textbase datasets while GIS databases consist of various data structures as described below:

1. Raster (MrSID, BIL, Grid, GeoTIFF, IMG, etc.)
2. Vector (DLG, TIGER, VPF, DXF, DWG, MIF, SDTS, shapefile, etc.)
3. Numeric datasets like GPS.

The functions of GIS librarian is defined as "a library professional with knowledge of GIS data models, concepts, techniques, technologies, and information and library science, and who can apply this knowledge in collecting, organizing, disseminating, and preserving geographically referenced data, providing general help in GIS reference and in displaying geospatial data." (Shawa, 2002)

Literature Review

The role, requirements, functions, steps of implementing GIS and areas of utilization of GIS in the library scenario investigated comprehensively, the purpose of creating prototype and prototype development process explained systematically in the study. He described that "thematic mapping of libraries using GIS and forming Virtual Library Network on the internet brings a lot of convenience and economy." (Phadke, 2006)

(Kowal, 2002) focused upon the power of mapping and capability of GIS to increase the accessibility of non-textual resources. He categorized high level, medium level and low-level services based upon GIS. The basic requirements and examples of GIS-based services are depicted in this study. Geospatial referenced data and GIS software such as ArcView or MapInfo could help to satisfy the high-level requests of GIS based services.

(Cline and Adler, 1995) pointed out that "GIS requires an understanding of computing and the ability to work with the visual representation of data, in addition to the knowledge and skills typically found in libraries relating to the organization of data, knowledge of information retrieval systems, reference services and collection development." The study also discussed the GIS project of Pennsylvania State University.

(Singer, Julie, and Williams, 2008) demonstrated hardware and software requirements for academic libraries to offer GIS services. They found "Libraries are seeing growing user

interest in GIS and in response are changing their staff, services provided, and collection development policies to accommodate this demand." The study discussed how Stanford University Library System adopted GIS to provide library services to various patrons. Library users are interested to retrieve data from GIS to solve their specific requirements. While (Morries, S, 2006) investigated opportunities and challenges associated with geoarchiving and geospatial web services. "In the new era of distributed, interoperable map services, libraries will have an opportunity to explore new roles as portals to streaming content available in the form of geospatial Web services." He discussed data collection, technical approach to deliver geospatial data, data discovery tools, workshops, technical support, training, etc. GIS service components and indicated the advantage of geospatial web services is that one can access current large datasets over low bandwidth. He felt that an infrastructure-based approach is required for the preservation and North Carolina Geospatial Data Archiving Project (NCGDAP) discussed in this study.

(Kollen, Dietz, Suh and Lee, 2013) emphasized the usage of geospatial data catalogues to provide geospatial data. Availability of data from a variety of formats (such as KML, GeoTiff, shapefiles) access to authoritative data for a specific region and searching and retrieving data from off-campus are merits that users can be offered. The lack of standards, time-consuming process of data addition, updating, editing, handling of different metadata schemes etc. are some issues related to the creation and maintenance of geospatial data catalogues.

(Given & Archibald, 2015) studied Visual Traffic Sweeps (VTS) for mapping users' activities on the library premises. VTS will help to analyze the habits of library users that will lead to better space management. The ArcGIS software is used in this project and they found that "By applying a visualization technique, evidence-based design decisions, such as changing the layout of furniture or renovating spaces to provide in-desk power for portable devices, can inform librarians and administrators' decisions to implement change."

The study investigated interdisciplinary research about application and researches of GIS technologies in bibliometrics, availability and access to e-journals support knowledge flow of citations widely which provides a new direction to GIS linked indicators of bibliometrics and spatial analysis. (Xuemei, Mingguo, Xin, and Zhiqiang, 2014)

(Rosichan, 2019) explained the role of GIS in mapping of literacy outreach programs for adults. Using ArcGIS to identify areas where services are required and study would help to raise funds for outreach services. The census data and data collected by Nashville Public Library's Adult Literacy Divisions are a used in this project.

Purposes and advantages of using GIS in the library

1. The emergence of new technologies, information explosion and availability of data in various formats make the role of librarians more challenging; GIS products provide the framework and technological infrastructure to handle spatial information and to provide innovative services. The application of GIS support R & D, education, provides access to spatial information, helps to handle and retrieve map collections and to preserve spatial resources efficiently.
2. Mappling library collection and surveying library service areas.

3. For efficient planning of library space management GIS technology would help to study the utility of library space and occupancy of patrons in the library. By analyzing the geographical distribution of library users inside and outside the library, analysis of the utility of library building and decision about opening branch of the library in particular location etc. facilities would be planned with a futuristic approach.
4. It is said that "A picture speaks more than thousand words", GIS helps for creating thematic maps and to provide user education. By preparing maps of library floors, shelves in the digital and visual format would help to aware patrons about the location of various sections of the library and finding details of the location of library reading materials easily and timely.
5. GIS technology can be utilized for mapping of book distributors or suppliers, it will solve the problem of delay delivery of documents, selecting suppliers near to library will save time, transportation expense, reduce the emission of CO_2 and assists form network of suppliers/ distributors.
6. The usage of GIS would help to analyze demographic characteristics of library patrons' comprehensively.
7. GIS technology can be applied to form a virtual library network and for planning networking based activities and services.

Utilization of GIS in the library and Information Centers

Traditionally application of GIS is common in areas of resource management, analyzing lands and crops, disaster management, defense, health sector to study the pattern of disease spread, to study whether and environmental factors in the world including India. However, in the LIS field application of GIS remains at the initial stage in the Indian scenario. While analyzing broadly in the context of libraries, application of GIS is found to study library space management, to form a virtual network of libraries, user education, to create systematic shelving model, examining location details of library users, visualize location details of documents on racks and mapping of book suppliers/ distributors. (Shastri & Chudasma, 2013)

The Information about GIS products used at Dornsife School of Public Health, Drexel University Libraries and the Role of Drexel Libraries in Providing Geo referenced information Services to community using GIS

The use of GIS at Drexel University is a collaborative effort between the Drexel Information Technology (IT), Drexel University Libraries and individual schools and departments across the university. Drexel IT administers the educational site license for ESRI products, assists staff and faculty with installation of software and maintains computer labs with GIS software. Drexel Libraries assists users with finding spatial data, organizes educational events and maintains public computers with GIS software. A department particularly active in using and promoting GIS at Drexel is the Urban Health Collaborative at the Dornsife School of Public Health. The Urban Health Collaborative employs a full time GIS analyst who helped to respond to this survey.

Sr. No.	Information of GIS	Details
1.	Year of origin of the Drexel University	1891 in Philadelphia
2.	Objectives of Drexel University Libraries	• Serve as educators. Librarians coach students and other learners to become confident and expert in their information literacy skills and they build partnerships with faculty and other campus experts to support discipline-based teaching and learning. • Support education and research through services that provide convenient, reliable, efficient and cost effective access to information resources. • Collaborate with researchers on informatics and data curation issues. • Foster intentional learning outside of the classroom, in both physical and virtual spaces.
3.	GIS based library and Information services	GIS services are primarily offered at the main library (W. W. Hagerty), but staff at other libraries can assist users or refer them to staff with the expertise they need. The services offered are: • To provide access to ESRI's ArcGIS desktop and online software, ESRI's Business Analyst Online is a web based tool that offers facility of creating maps, reports from business, crimes, demographics, behavioral and US traffic data etc., more than 135 nations data and reports are available that will help to study site selection, market planning, and consumer segmentation decisions. ESRI's Community Analyst Online also provides service to create maps, reports and infographics. • Article finding services from Scopus, Materials Science and Engineering databases, GreenFILE and Proquest (biological Science).
4.	GIS Software/ Products used	ESRI's ArcGIS Desktop Software- ArcGIS Online, ArcGIS 10.x:, ArcGIS Pro

5.	GIS data sources	Pennsylvania Spatial Data Access (PASDA)
		Open Data Philly
		US Census American FactFinder
		USGS National Map
		US Census Bureau Data Mapper
		ArcGIS Living Atlas of the World
6.	The Role of Government	Drexel is a private university, US government funding supports research grants which are used to acquire spatial data and support research staff. Drexel researchers work in collaboration with government agencies.
7.	Purpose of Using GIS	Research, academic and administrative work of the Drexel University
8.	Information about the department/s monitor and disseminate Geospatial/ GIS tools and information services	Dornsife School of Public Health
		College of Engineering
		College of Arts And Sciences
		College of Computing & Informatics
		Academy of Natural Sciences
9.	GIS staff qualification	Drexel GIS staff has expertise primarily in particular research disciplines and have GIS expertise gained from applying GIS to projects in their disciplines. The Urban Health Collaborative GIS Analyst has a MS degree in the Civil Engineering.
10.	How can Community access GIS software	Staff members who interested in using GIS can contact DU IT Help Desk at 215-895-2020 or send an email to accounts@drexel.edu.
		If a faculty member authorizes students to utilize ArcGIS for instructional purposes, he or she must request that access be granted to these students via the Web form at http://www.esri.com/industries/apps/education/offers/promo/index.cfm
		ArcGIS installation can be done at university owned computers or personal computers used for academic or research purposes only.

11.	No. of approx. GIS users (annually)	450 (Based on ArcGIS online members)
12.	Discipline wise major users of GIS data services	Public Health Environmental Engineering Biodiversity, Earth & Environmental Science (BEES) Criminology & Justice Studies Business Sociology Computer Science
13.	GIS data service hours	GIS data service would be part of library's routine services, contact via email, Thursdays from 2:30 – 4:00 p.m. at the Urban Health Collaborative.
14.	Information about organization of GIS workshop	For credit classes are offered to students by Dornsife School of Public Health and the College of Engineering. The Urban Health Collaborative offers a one week summer institute class. Workshops are held irregularly on special topics, such as accessing census data.
15.	Information about attendees of GIS workshops	Students, faculty and staff
16.	How GIS help Drexel University	The Library helps people locate spatial data. Drexel IT helps with software and access issues. Individual schools offer additional help with the Urban Health Collaborative primarily supporting public health research.

Other Case Studies

Enormous studies have been found to demonstrate utilization of GIS in the library scenario; however an attempt has been made to describe a few pertinent studies. The Information of libraries using GIS, the usage of GIS products/ software/tools and major areas of usage of GIS in the library scenario are viewed and described as below:

Armidale City Public Library, New South Wales used GIS product- PC ARC/ INFO to study active and inactive adult borrowers of Armidale City Public Library (Jones, 1993).
While the pattern of location of library, race and income of patrons in St. Louis, Missouri metropolitan area studied by using ESRI ArcGIS software, version 9.0, TIGER files, US census data, iTouchMap and Google maps. The study examined library distribution, density analysis, household income, library location by race-population of Hispanic and African American etc. factors (Wallington, 2013).
By using ArcView software, MacKimmie Library at the University of Calgary, Canada initiated the study of pick-up books from library shelves. The study also highlighted the

habitual pattern of library patrons about browsing shelved materials, suggests more convenient ways of rearrangement of library materials. (Xia, J. 2004).

Visualization of books on shelves and Library Space Information Model was developed at Shanghai Jiao Tong University Library; ArcGIS 10.3 trial version product is used in this project. (Shen, Y, 2018).

Demographic analysis of service area-race wise population, age, education, and median household income etc. studied with the help of ArcGIS, US census data at the East and West branch of Boise Public Library. The finding of the study would help to analyze critically collection and services of Boise Public Library with futuristic approach. (Hertel, K., & Sprague, 2007).

Another interesting study is about Lake Country Library System (LCLS-comprised of 13 public libraries), Florida, by using ArcGIS 9.2, the analysis of the location of public library registrants, travel distance per ethnic groups and mapping of service areas of libraries of Lake Country demonstrated. (Park, 2012)

Moreover the University of Kansas Libraries analyzed GIS services at the KU libraries; information of attendees of GIS workshops was also collected by using ArcGIS and ArcView. (Houser, 2006)

While Physical behavior of library patrons was studied by utilizing ArcGIS, Auto CAD software at Central Library of Tehran University. Findings of the study would assist in the planning of library space management and library facilities of the study halls of the document center in the future. (Pournaghi, R, 2015)

India's Vision on GIS

Library automation, Content Management Systems (CMS), digital library (Institutional repository), Web 2.0 or more tools, cloud computing, RFID, etc. technologies are utilized widely in the Indian library scenario.

India is utilizing modern geospatial technologies by Indian Remote Sensing Satellites since the 1980s, however, the application and use of GIS is new in the Indian library scenario. During the twelfth five year plan (2012-2017), the innovative project of the National GIS of India was initiated and India's challenges with the implementation of geospatial technology and futuristic approach were discussed comprehensively. (India: A Vision for National GIS, 2014) Primary features of India's National GIS vision was to build up networking infrastructure and GIS-centric computing for national GIS platform, creation of national GIS portal, disseminate GIS services to government departments, citizens and private enterprises and for National GIS formulation of realistic and sensible Geographic Information (GI) policy. At present the Indian Education system is also moving towards the development of technological infrastructure and skill development among learners rigorously.

India Knowledge Hub(IKH) which is created by NITI Aayog (formerly Planning Commission) discussed Haryana Election Geographic Information System (HEGIS) project. (NITI Aayog, http://www.indiaknowledgehub.gov.in)The outcome of this project includes advantages of availability of GIS-based map of the entire state, supporting data security and disaster recovery by hosting the application on GI cloud, cloud platform facility, information about health facilities, police stations, fire stations with location and address; integrated capabilities for the GIS location-based analytics, planning, decision

support systems and support in the delivery of services during the Pre, Poll and Post Poll phase, etc.

Many conferences, workshops. seminars and programs about GIS projects are organizing in India at the national and international levels regularly. The 20th edition of GeoSmart India conference–a significant geospatial event organized at HICC, Hyderabad during December 2019 with the theme of Ignite-Innovate-Integrate to strengthen Indian Geospatial ecosystem. (GeoSmart India, 2019) National geospatial information infrastructure, geospatial strategy for new India, smart cities and agriculture, geo4SDGs, geo-intelligence etc. themes were discussed through inspiring and immersive presentations and talks during the conference. India is adopting emerging geospatial technologies for the development of opportunities and dynamic growth of the nation; it is also providing an attractive platform through GeoSmart India to the world. However there is need to emphasize upon GIS based library services, the study identifies core challenges regarding application of GIS in the context of Indian libraries.

The challenges and solutions about the usage of GIS in Indian Library Scenario:

1. The project of implementation of GIS in the library is resource-intensive. It requires software, hardware, long term financial investment, experts, and efficient planning strategy.
2. FOSS GIS software have limitations, while the high cost of efficient proprietary GIS software/ tools is one of the crucial factors behind low usage of GIS in the library scenario. It is required to focus and initiate research about GIS and library, need to strengthen financial resources and networking among libraries is required.
3. Unavailability of GIS software experts in the library field is observed, moreover due to lack of awareness about GIS technology among library professionals in India, the advantages and utility of this technology are not recognized fully. It is imperative to begin GIS literacy projects for LIS professionals or to employ GIS specialists in libraries.
4. The state, private and public universities and Library Associations of India should organize seminars, workshops, and short term courses to aware and develop GIS skills among professionals serving in the libraries at the regular intervals.

Conclusion

In the beginning, GIS used extensively in the discipline of engineering, computer science, geography, geology, and space technology. In the course of time, the advantages of mapping and the value of spatial data increased, so the utilization of GIS also extended. It is observed that to study library patrons' behavior, library space management, library collection management, bibliometrics, studying demographic characteristics of users, evaluating library service area especially in case of the public library and forming virtual library network, GIS proved beneficial in LIS field. The study identified and discussed significant case studies of usage of GIS. In order to provide efficient GIS services, availability of GIS experts or LIS professionals should acquire spatial data management skills, besides the financial support, and strategic planning are core requirements to adopt GIS technology in the Indian library scenario.

Acknowledgement:

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