



## Sustainable development initiatives in libraries: A critical analysis

Debabrata Manna<sup>a</sup> and Tanmay De Sarkar<sup>b</sup>

Deputy University Librarian, Central Library, University of Calcutta, Calcutta, West Bengal, Email: dmanna@caluniv.ac.in  
Assistant University Librarian, Central Library, University of Calcutta, Calcutta, West Bengal, Email: tdesarkar@caluniv.ac.in

*Received: 31 August 2022; accepted: 30 December 2022*

The purpose of the present study is to give an overview of the sustainable development (SD) initiatives observed among the selected libraries around the world. The present study employed a web-based content analysis method among the selected academic and public libraries to investigate the adherence of features of the green library. Based on the survey of library websites and reviewing related literature, the study identified the parameters contributing to the sustainable development intent of the library. With examples, this study also showcases the current practices followed by the libraries to implement green library strategy. Moreover, the challenges faced by the libraries in their effort to go green was also identified and discussed. The overview of SD initiatives among different libraries as displayed in the study will improve the understanding of the adoption of green indicators by the librarians and information science professionals.

**Keywords:** Acoustic management; Carbon footprint, Chatbot, Crowd funding, Energy Conservation, Green library, Robotics, Sensor, Sustainable goals

### Introduction

According to IFLA, “a green and sustainable library is a library which takes into account environmental, economic and social sustainability”<sup>1</sup>. While highlighting the basic features of a green library, IFLA formulated a list of criteria. Going deep into the major features of a green library as proposed by IFLA, it was observed that the following parameters are of prime importance:

- The emissions from the library building concerning greenhouse gases like CFC, CO<sub>2</sub>, CH<sub>4</sub>, NO, etc., are to be minimized to a considerable extent
- Environmentally sustainable operational procedures in all sections of the library need to be followed
- With regards to service provision, measures are to be employed to ensure optimum utilization of shared equipment, devices, and spaces.
- Attention to be paid toward updating the information regularly regarding resources and facilities offered by the library
- Easy and speedy access to library resources is to be ascertained
- Libraries are required to undertake outreach services with a view to social inclusion, ensuring participation from society
- Adoption of emerging technologies may be considered given the adequate facilities that exist,

engaging user services with the implementation of smart devices and intelligent service provision around the library service provision

The very idea of a green library is the sustainable use of resources and infusing minimum harmful ingredients into nature to take active participation in the ecological life cycle<sup>2,3</sup>. Realizing the need to save the environment, the green library movement was initiated long ago in the 1990s<sup>4</sup> wherein stress had been given to bring about a change in policy decision to replace the use of bio-degradable products with their non-biodegradable counterparts and adopt a practice to develop an eco-friendly library architecture minimizing environmental impact. A primary shift to the green library design component starts from its architectural fabric.

### Review of literature

A study on the existing literature around the concept of the green library revealed that majority of the researchers while highlighting green libraries, mainly focussed on green buildings<sup>5,6</sup>. Consequently, there was a tendency to stress the design architecture of a building to achieve more points on a rating scale following sustainability certification issued by the LEED (Leadership in Energy and Environmental Design). Reitz<sup>7</sup> asserted that the new construction and renovation carried out in existing construction are required to follow the criteria as said by the LEED

based on the rating system developed by USGBC (US Green Building Council).

However, the concept of a green library has a major connotation that includes conservation of resources (water, power, paper) and utilization of recycled products with proper waste management to reduce the negative impact on the outdoor environment and improve the quality of the indoor environment<sup>8,9,10</sup>. That the green library is not necessarily limited to the concept of a certified green building is argued by Aulisio<sup>11</sup> long ago, who even went to the extent of saying that a green library promotes sustainability through operation and outreach. Therefore, coming out of just the green building, the concept of a green library encompasses its equipment, location, people, resources, activities, services, events, and processes that are carried out in and around the building<sup>10</sup>.

Interestingly, Kurbanoglu and Boustany<sup>12</sup>, opined that the concept of green library centers around multi-faceted components involving “green buildings, green operations, and practices, green programs and services, green information systems, [and] green collections”. Meanwhile, Chowdhury<sup>13</sup> stressed the importance of offering library services with green components in mind. He coined the term “green information service” where information acquisition, processing, storing, and dissemination intend to minimize the harmful effect on the environment.

While illustrating the dimensions of sustainable development, Khalid, *et al.*<sup>14</sup>, pointed to a three-way sustainability aspect as proposed by Elkington<sup>15</sup> in his “triple bottom line” principle, where social, ecological, and financial components formed the very basis of it. Khalid, *et al.*<sup>14</sup>, further opined that all libraries across the globe are required to be “socially, environmentally and economically sustainable” to be able to cope with future generations. Additionally, IFLA<sup>16</sup> mandates that the libraries being social institutions, have social roles to play and suggests that they develop an improved understanding of how to sensitize the community people to behave responsibly while embarking on environmental practices. As a step forward, several international library associations and organizations like IFLA, ALA, etc. are “furthering, supporting and integrating sustainability in their practices”<sup>14</sup>. Thus, a library can participate in the green movement by actively educating the community about the sustainable use of resources.

Giving credence to the green movement, libraries are trying to promote the use of resources sustainably

and improve the understanding of the community about the environmental issues and familiarize them with ways how to minimize harmful effects on the environment. Green library initiatives may have already taken place in developed countries going by the infrastructure, financial sustenance, and ease of communication with supportive equipment, however, in developed and underdeveloped countries adoption of green library features is sparsely noticed<sup>17,18,19</sup>. Therefore, the present study was undertaken to give a synthesis of how libraries around the world have incorporated green library practices and contributed to sustainable development.

### Objectives of the study

- To identify the parameters contributing to the sustainable development intent of the library;
- To give an overview of sustainable development initiatives among libraries around the world; and
- To find out challenges obstructing the progression towards sustainable development.

### Methods

The terms sustainable development and going green are used interchangeably<sup>20</sup>. The present study involves reviewing related literature to develop a thorough understanding of sustainable development initiatives. Furthermore, a 2-step web-based content analysis<sup>21</sup> method was employed among different libraries, both academic and public, to investigate the adherence of features of the green library. The two distinct categories of libraries were selected based on the intent of the users since the academic libraries cater to the academic and research needs of the users of parent universities and public libraries satisfy the needs of the community users having multi-dimensional information quest. 50 academic libraries (Annexure-1) and 50 public libraries (Annexure-2) were selected using a convenient sampling method from the following directories. Since there is no comprehensive directory available enlisting all the academic and public libraries across the continents, the researchers consulted a group of directories to construct 2(two) sampling frames, one each for the academic libraries and public libraries. Directories surveyed to create a sampling frame for the academic libraries, especially those under higher education institutes are given below :

- <https://www.timeshighereducation.com/world-university-rankings/2021/world-ranking>

- <https://www.topuniversities.com/university-rankings/world-university-rankings/2021>
- <https://www.shanghairanking.com/news/arwu/2021>
- <https://www.nirfindia.org/2022/EngineeringRanking.html>

For the construction of sampling frame for the public libraries, following directories/websites were consulted:

- <https://librarytechnology.org/libraries/uspublic>;
- <https://www.libdex.com/country>;
- [https://www.gpntb.ru/win/libweb/index\\_e.htm](https://www.gpntb.ru/win/libweb/index_e.htm)
- [https://en.wikipedia.org/wiki/List\\_of\\_national\\_and\\_state\\_libraries](https://en.wikipedia.org/wiki/List_of_national_and_state_libraries);
- <https://publiclibraries.com>;

Selecting the above libraries, the researchers followed a 2-step content analysis method<sup>22</sup> to investigate the degree of adherence of green library criteria by the selected libraries (Fig. 1). The first step

of content analysis involved identifying the green library features among the libraries. At first, the library website is searched to identify links associated with green library criteria. In case of unavailability of suitable results, search was conducted in the library site search box. If still the process failed to yield a positive outcome, library specific website search was conducted in Google, using the following keywords: green library, sustainable development, carbon footprint, energy consumption, sound masking, etc.

Once the criteria is identified, the 2<sup>nd</sup> step of content analysis was initiated, wherein, the features associated with the criteria and relevant links were analyzed and connotations were scanned to decipher how libraries prepare themselves for sustainable development perspectives.

Based on the identification of green library features (Table 1), the degree of prevalence of sustainable development initiatives among the libraries across the

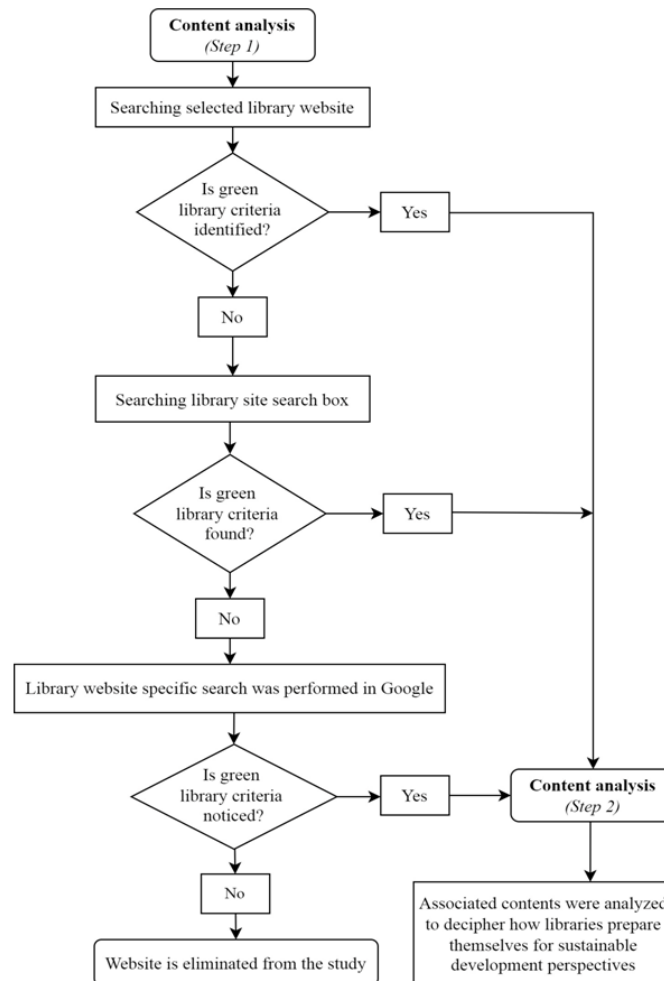


Fig. 1 — Two-step content analysis method to identify relevant criteria associated with the adoption of green library features (adapted from De Sarkar<sup>22</sup>)

Table 1 — Sustainable development parameters for libraries

Sl. No.	Parameters	Statements
1	Carbon footprint	Instrument to measure carbon footprint Initiatives to reduce carbon footprint
2	Energy consumption	Installation of solar panels/use of cow-dung gas/wind, etc. Installation of LED bulbs Provision of receiving sunlight Proper illumination Installation of sensors to control energy consumption Ample scope for energy conservation
3	SD policies	Policies on sustainable development
4	Green transition from print to electronic	Digitization initiative Presence of e-resources
5	Library funding	Fund generation Crowd funding
6	Library location	At a prominent place in a city/town Well connected via all sorts of transport system Close to the library building existence of different value-added amenities (e.g. small water bodies, coffee shop, gym, indoor game platform, group discussion platform, etc.) Presence of vegetation in and around the library Away from the noise zone like club, auditorium, entertainment hall, etc. Nearer to other service provider buildings
7	Temperature control mechanism	Installation of ACs Installation of sensors to operate ACs
8	Provision of air movement	Air ventilation and purification system Relative position of windows Size of windows No. of windows Glass windows Free space between adjacent shelves
9	Nature of furniture	Use of adjustable steel racks Proper arrangement of shelves, tables and chairs Retractable ladder
10	Building architecture	Separate building plans for hilly/plain/coastal/desert area Floor height Open space Installation of transparent sheet at the roof to allow filtered sunlight Width of the wall Installation of elevators Presence of wheelchairs Tactile buttons/steps for visually challenged patrons Car parking facility (over ground/underground) Vegetative roof / eco-roof / rooftop planting Building materials must be recyclable and environment friendly
11	Acoustic management	Hollow space inside the wall Decibel detecting sensor Wall mounting of vibration absorber
12	Water management and conservation	Rainwater harvesting and its use for toilets, bathrooms, gardening and cleaning etc. Reuse of treated sewerage water Provision of drinking water Save of drinking water Proper drainage system Installation of waterless urinals Installation of sensors for water conservation

Table 1 — Sustainable development parameters for libraries (*Contd.*)

13	User involvement in green initiative	User orientation programme to grow awareness on sustainable development initiatives among users Promotion of SD initiatives via website and popular social media platforms Organisation of SD workshop Proper mounting of signage on SD initiatives to enhance visibility Initiatives to reduce occupational health hazards
14	Installation of fire-safety devices	Installation of sensor-based smoke detection system Installation of sensor-based automated foam ball for fire fighting
15	Optimization of library services	Optimum utilization of shared devices Optimization of resource sharing Automation of library services Provision for off-campus access of resources and services Focus on use of open source software Emphasis on consortia approach Collaborative library activities via cloud computing Provisions for easy and speedy retrieval of resources Periodic updation of library resources and facilities Increased provision of librarian-user interaction Undertaking promotional activities Improved presence in social media for better online experience Initiation of outreach activities
16	Intelligent library service	AI mediated reference service Use of chatbots Sensor controlled library tour AI mediated fees / overdue charge collection mechanism Sensor mediated retrieval system Sensor based circulation system Use of robotics in library

continents were analysed using excel sheets. Against each of the libraries, adoption of SD initiatives along the 16 major parameters were studied. Existence and non-existence of any of the parameters against a library were marked with integers 1 and 0 respectively.

### Analysis, findings and discussion

#### *Identifying the parameters contributing to sustainable development*

Searching relevant criteria in literature and employing researchers' practical knowledge, parameters of green library initiatives were identified and categorized. Moreover, web-based content analysis was employed using keywords relevant to green library indicators to find parameters framed for the survey. The framework for the parameters quantifying green library is devised (Table 1).

The carefully chosen parameters/indicators including sub-divisions of each of them constitute the basis on which the sustainable development initiative of a library can be measured in future research. A model approach (Fig. 2) to sustainable development

initiative has been presented diagrammatically to



Fig. 2 — A model approach to guiding libraries to achieve sustainable development

assist library professionals in developing an understanding of the basic indicators required to be

satisfied towards achieving sustainable development goals.

*Parameter-wise sustainable development initiative among libraries around the world*

*Carbon footprint*

Libraries have a definite role to reduce carbon footprint and grow awareness among users to reduce carbon footprint and limit greenhouse gas production. In library collection and services, the use of digitized resources and furniture made up of recyclable materials can drastically reduce carbon footprint. The King County Library System has achieved “carbon neutral” status by applying “Puget Sound Energy’s (PSE) renewable energy programs” (<https://kcls.org/news/the-king-county-library-system>) and users were also guided to reduce carbon emissions to the environment. Meanwhile, the University of Wellington Library vows to achieve zero carbon emission by 2030 (<https://www.wgtn.ac.nz/sustainability>).

*Energy consumption*

Sustainable energy consumption is a major parameter for a library to go green. A study report from Fairfax county (<https://www.fairfaxcounty.gov/environment-energy-coordination/libraries>) reveals that 8 county libraries among 23 Fairfax county libraries have earned LEED Certification and carbon emission from energy consumption in terms of electricity and natural gas has been reduced to 41% from 2006 to 2019.

*SD policies*

Sustainable development policies being the precursor of a green framework of a library, many libraries have sound SD policies. For example, Stanford University Library, in its SD policies clearly demarcated the following: sustainable use of computing resources, guidelines for using food and drinks including the provision of handling pets in the library, photographic rules, provisions for using green library study rooms, eligibility to use lockers and assigned study spaces, etc. (<https://library.stanford.edu/green/building-policies>).

*Green transition from print to electronic*

The New York Public Library in its effort to make collections easily discoverable and to reuse in creative ways stressed digitization and digital preservation. The library identified over 4 lakh rare and at-risk items and digitized over 2 lakh items. Moreover, its Audio

and Moving Image (AMI) initiative prompted to preserve and digitize new acquisitions for posterity (<https://www.nypl.org/digital-research/projects>).

*Library funding*

The Ridgeland Public Library under the Madison county library system appeals for funds for the development of the library via crowdfunding using social media platforms. In addition to the usual mode of fund flowing, the crowdfunding system has the provision to generate funds involving the general public at large to minimize their financial burden (<https://www.mclsms.org/calendar/202207/Ridgeland-Public-Library>).

*Library location*

A location is very vital for users to smoothly get access to the library. A library at the heart of the city or town or any prominent place in urban/rural areas, well connected to all sorts of transport systems and away from noise zone is the prime requisite to function as a learning hub. The University of Stockholm Library is located at the University’s main campus in Stockholm, close to D-building ensuring that it has the facility for all sorts of communication, at the same time, at a relatively serene site inside the campus to reduce the impact of noise generated in the city (<https://www.su.se/stockholm-university-library>).

*Temperature control mechanism*

To maintain the healthy condition of books, a proper temperature control mechanism in a library is very essential. The Central Library of Seattle Public Library system comprising 11-floor with a book spiral, a huge auditorium, a large computer lab, and a robust underground parking lot, all are brought under air-conditioning system to maintain the conditions of books, equipment and give some respite to the users as well from unfavorable weather condition (<https://www.spl.org/hours-and-locations/central-library>).

*Provision of air movement*

The air ventilation and purification system of a library reduce considerably air-borne microbes and pollen grains including allergens and thus protect users from air-borne diseases including COVID 19. Installation of a three-level air purification system in Baker County Library helps in maintaining the circulation of sterilized and filtered air inside the building much to the relief of users in terms of

protection from a set of contagious diseases. The computer-controlled air purification system works on a bipolar ionization mechanism under an electromechanical system that is capable of eliminating 99.4% of virus particles within 30 minutes (<https://www.eastoregonian.com/news/baker-county-library>).

#### *Nature of furniture*

Furniture and related fittings in a library need to be made up of recyclable materials for “long-term sustainable response”. Moreover, furniture requires to be “attractive, durable and comfortable” as well as adjustable, workable, and sustainable to accommodate library items efficiently. The State Library, New South Wales stressed the installation of movable furniture and shelves to manage foot traffic and pull out extra spaces within the library. “Stackable chairs and folding tables” are capable to maintain social distancing during a pandemic-like situation. Furthermore, the Pod-style desk managed by library staff is helpful to move around the library and attend users (<https://www.sl.nsw.gov.au/public-library-services>).

#### *Building architecture*

The University of Illinois Library on its LibGuides page displays the “green building/facility management” module where detailed discussions on academic green building design, daylighting design in libraries, use of energy-efficient illumination system, and green building certification system were carried out (<https://guides.library.illinois.edu/green-libraries>).

#### *Acoustic management*

Since noise hinders the library environment, proper care has to be taken to reduce the noise level in the library. For this purpose, the implementation of acoustic management has been seen in many libraries. The Edmonton Green Library in its acoustic management engaged acoustic consultants to create an acoustically effective library environment and reduce user distraction. The library has introduced acoustic cost-effective furniture to minimize unwanted echo. Moreover, the library introduced a “sound masking” system to increase speech privacy in the library and diminish unwanted sounds with the help of low-frequency sound specially designed to cover up human speech (<https://www.fglibrary.co.uk/public>).

#### *Water management and conservation*

Water conservation signifies efficient management of water resources for its effective use and prohibits misuse keeping in mind the sustainability issues necessitating preservation for future use. The Santa Monica Public Library, under its stormwater management plan constructed a 2 lakh gallon underground water tank to store rainwater and utilize it to irrigate the garden areas around the library building ([https://smpl.org/Sustainability\\_Water\\_Management](https://smpl.org/Sustainability_Water_Management)).

#### *User involvement in green initiative*

The Orange County Library through its water conservation education program spreads awareness about the importance of water conservation and involves community members to initiate water management in their respective localities (<https://attend.ocls.info/event>). The Middle East Technical University (METU) in its SD policy prohibits the use of tobacco and guides users to contribute to the educational health of the institute. The METU also stressed reducing the use of dairy products and increase of plant-based products (<http://sustainablecampus.metu.edu.tr/en/policies>).

#### *Installation of fire-safety devices*

Installation of fire safety equipment and fire safety training for patrons reduces the risk of fire hazards. The Uppsala University Library besides installing fire safety devices, mandates all its staff to get fire safety training regularly under the supervision of a fire safety officer. The library ensures that every user is well aware of fire safety exits and the evacuation map (<https://mp.uu.se/en/web/info>).

#### *Optimization of library services*

Technological innovation supports value-added library services for the optimum utilization of resources. The University of Cambridge Library uses the LibKey Nomad browser extension, allowing researchers to get quicker access to resources via seamless connectivity with just one authentication step, while studying on the internet, contributing to the objective of optimum utilization of resources (<https://www.lib.cam.ac.uk>). The Networked Digital Library of Theses and Dissertations (NDLTD) promotes acquisition, management and dissemination of digitized theses collected from across the globe. Libraries in different nations channelize their theses submission to NDLTD for global accessibility and encourage sharing of knowledge resources (<https://ndltd.org>).

To increase user interaction with the library and to encourage user engagement, the University of Otago Library in its facebook page uploads special collections and, news and events to promote library activities via social media to reach out a broader section of the community easily (<https://www.facebook.com/otagospecialcollections>). While promoting off-campus access to resources and services, the Imperial College of London Library offers proxy bookmarklet for users. It allows users to get the benefit of library services and library holdings via user authentication by clicking the installed add-on from any web page while off-campus. The bookmarklet relieves users from multiple clicking, right from visiting the library webpage to get access to desired resources while not being present within the campus (<https://www.imperial.ac.uk/admin-services/library>).

Supporting IFLA guidelines towards sustainable development initiatives, libraries offer outreach services for social inclusion. The Queens Public Library undertakes programmes to reach out to correctional homes, shelters, healthcare facilities, community centers etc.. To ensure increased participation from the members of the society, the library organizes all kinds of street fairs and religious events and strengthens library-community bonding (<https://www.queenslibrary.org/programs-activities>).

#### *Intelligent library service*

Robotics has made a sharp in-road to library service provision. The use of chatbots carrying out the role of a reference librarian and the presence of telepresence robots communicating with the users and satisfying their information needs is observed in some libraries. The University of Oklahoma Library using its chatbot not only performs the task of a subject librarian but at the same time teaches users how to search and find desired documents using natural language without the use of keywords. Thus simplifying the search procedure based on users' search intent is the application of AI and natural language that brings the library towards an intelligent learning hub (<https://libraries.ou.edu/content/introducing-bizzy>). The Joe and Rika Mansueto Library, University of Chicago, uses robot cranes for searching, retrieving, and placing books in the underground book stacks. The AI-mediated cranes have the ability to fetch books within 3 minutes of placing a requisition (<https://www.lib.uchicago.edu/mansueto>).

#### *Identifying challenges obstructing sustainable development initiatives*

It has been observed that some of the libraries (University of Illinois Library, Cambridge University Library, University of Canterbury Library, Hong Kong Polytechnic University, National Library of Singapore, Los Angeles Public Library) have demarcated in their website sustainable development policies. However, the majority of the libraries have no specific SD guidelines. A clear sustainable development policy guideline is very essential to attain SD goals. Since it is easier to adopt green initiatives by the upcoming libraries rather than the existing ones, the libraries already established and having a little scope of expansion and under limited budgetary allocation shall require scheme-based implementation of green library features. However, it has been observed that the aesthetic quotient in library design seldom sacrifices the green library attributes<sup>23</sup>.

Though initiatives have been taken by some libraries to reduce carbon footprint still the majority of the libraries do not have carbon emission measuring equipment to monitor carbon emissions regularly. Notwithstanding, as opined by Schopfel<sup>24</sup>, carbon emission in libraries is marginal compared to that of power plants, transport, and industries. However, since energy consumption contributes significantly to carbon emission, with the modernization of libraries and installation of various electricals and electronic devices, we cannot ignore the increased existence of carbon footprint in the library. Green library service intends to provide information support more quickly and easily. However, streamlining library services and improving user experience underlines enhanced technological involvement that in turn has a detrimental environmental impact - a notion supported by Kruse<sup>25</sup>.

Library space management is also a major challenge faced by many libraries. As observed by Khalid, *et al.*<sup>14</sup>, a green library requires considerable floor heights for smooth movement of air. However, libraries with increased stack-weight give little space for air movement and impact on library health.

#### **Discussion**

Data analysis among the libraries to investigate the degree of adoption of SD initiatives reveal that academic libraries fare well compared to that of public libraries. Since academic libraries of higher education institutes basically cater to the needs of leaners of higher studies compared to that of public



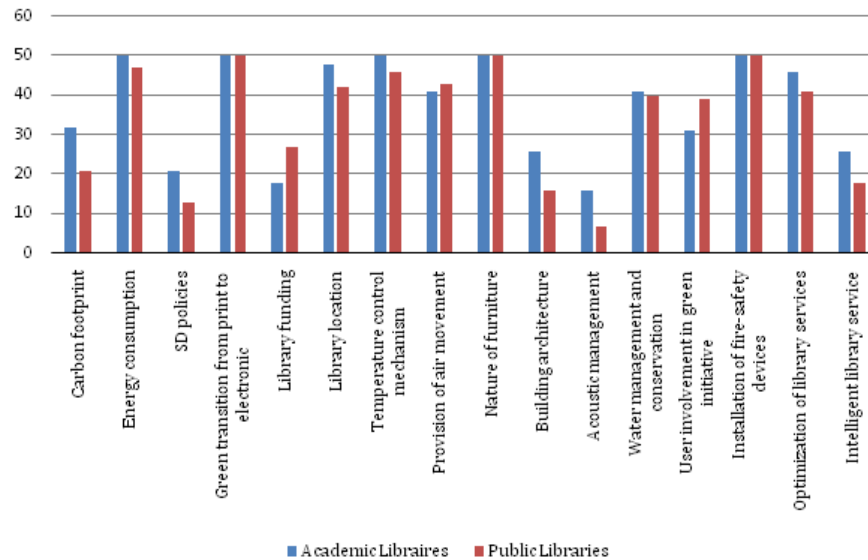


Fig. 3 — Criteria-wise adoption of green library features among academic and public libraries

libraries, perhaps more attention to SD initiatives are given to the academic libraries. Moreover, in the pursuit of research and higher learning academic libraries receive considerably more funds from different grants than that of public libraries. Therefore, academic libraries could embark on major refurbishment initiatives to adopt green library features easily.

A comparative study among the public and academic libraries selected for the present investigation gives an overall idea how different features are adopted among the libraries. It has been observed that among the green library features the degree of adoption of acoustic management is lowest among the criteria studied. Almost all libraries have their own reduced energy consumption mechanism, undertake activities for green transition from print to electronic, have sustained temperature control mechanism, use green furniture and adopt fire safety devices (Fig. 3). However, sustainable development policies among the libraries are fairly missing. Moreover, user involvement in green initiatives, particularly in academic libraries need to be improved to make them aware of the benefit of sustainable development initiatives across the society. Since artificial intelligence have already been adopted by libraries, measures need to be adopted to use intelligent service facilities to reduce carbon footprint effectively.

The above study gives a brief synthesis of green library initiatives among libraries across the diverse

geographical region. Increased attention toward sustainable development necessitates libraries for the improved adoption of green features. Aulisio<sup>11</sup> clarified that a green library is not indicative of green architecture but green action as well. Giving due importance to the green movement IFLA announces green library awardees every year for the past 7 years. Environment, Sustainability and Libraries (ENSULIB) wing under IFLA, has announced the top ten green libraries for 2022.

The National Library of Singapore is the only library awarded in Asia for adopting green library features. The Central Public Library located in Singapore National Library is considered the “first green library for the kids” especially for its “tree house canopy” built with recycled bottles and the basement with a staircase made up of “recycled timber”. Moreover, the bookshelves were reconstructed with the addition of recycled materials, and an energy-saving illumination system was also introduced in the Library (<https://www.nlb.gov.sg>).

The Regional Library “P. K. Yavorov” of Burgas, Bulgaria has taken a significant role in digitizing its vast resources of “books, catalogs, and photographs”. Besides green infrastructure, among other green initiatives, the library organizes various events like study circles, book reviews, exhibitions, screening of films, etc.

The green library initiatives in India are rather restricted to basically around issues relating to provisions of maximum entry of sunlight, movement

of free air, basic cleanliness, and suitable arrangement of library furniture<sup>26</sup>. Bangar<sup>27</sup> observed that NIT Silchar was the first building designed according to LEED certification in the northeast.

## Conclusion

Libraries of repute under British imperialism were mostly built following gothic architecture and therefore, had the privilege of having some inherent green attributes. However, the overview of SD initiatives among different libraries as displayed in the study will improve the understanding of the adoption of green features by the librarians and library planners. The challenges discussed above need greater attention to address issues inconveniencing the green library implementation initiatives.

## References

- 1 IFLA, What is a green library?. Available at <https://www.ifla.org/ifla-green-library-definition>(Accessed on 22 Feb 2022).
- 2 Brown B, The new green standard, *Library Journal*, 128 (20) (2003) 61-64. Available at [www.libraryjournal.com/article/CA339607.html](http://www.libraryjournal.com/article/CA339607.html) (Accessed on 17 Apr 2020).
- 3 Meher P & Parabhoi L, Green Library : An overview, issues with special reference to Indian libraries, *International Journal of Digital Library Services*, 7 (2) (2017) 62-69.
- 4 Antonelli M, The green library movement : An overview and beyond, *Electronic Green Journal*, 1 (27) (2008). Available at <https://escholarship.org/uc/item/39d3v236> (Accessed on 22 Jan 2022).
- 5 Meyer J, Global warming's library challenge, *Library Journal*, 133 (18) (2008) 26–29.
- 6 Sahavirta H, ,proud that my own library is such a responsible operator!, In Hauke P, Latimer K and Werner KU (eds), *The Green Library, The Challenge of Environmental Sustainability = Die Grune Bibliothek: Okologische Nachhaltigkeit in Der Praxis*, Berlin and Boston, MA: De Gruyter Saur, 2013, p. 317–332.
- 7 Reitz J M, *Online Dictionary for Library and Information Science*, Santa Barbara, CA : ABC-CLIO, 2013. Available at [https://www.abc-clio.com/ODLIS/odlis\\_1.aspx](https://www.abc-clio.com/ODLIS/odlis_1.aspx) (Accessed on 17 Jan 2022).
- 8 Rickert K, Greening our college libraries: complete the cycle of the three Rs, *College & Research Libraries News*, 62 (8) (2001) 825–828.
- 9 Fourie I, A call for libraries to go green: an information behaviour perspective to draw interest from twenty-first century librarians, *Library Hi-Tech*, 30 (3) (2012) 428–435.
- 10 Fedorowicz-Kruszewska M, Green library as a subject of research : a quantitative and qualitative perspective, *Journal of Documentation*, 78 (4) (2021) 912-932.
- 11 Aulisio G J, Green libraries are more than just buildings, *Electronic Green Journal*, 1 (35) (2013). Available at <https://escholarship.org/uc/item/3x11862z> (Accessed on 14 Feb 2022).
- 12 Kurbanoglu S and Boustany J, *From Green Libraries to Green Information Literacy*, (2016) Available at [https://www.academia.edu/20699582/From\\_Green\\_Libraries\\_to\\_Green\\_Information\\_Literacy](https://www.academia.edu/20699582/From_Green_Libraries_to_Green_Information_Literacy) (Accessed on 14 Jun 2022).
- 13 Chowdhury G, Building environmentally sustainable information services: a green IS research agenda, *Journal of the American Society for Information Science and Technology*, 63 (4) (2012) 633–647.
- 14 Khalid A, Malik GF and Mahmood K, Sustainable development challenges in libraries: a systematic literature review (2000–2020), *The Journal of Academic Librarianship*, 47 (3) (102347) (2021) 1-9.
- 15 Elkington J, *Cannibals with Forks: triple bottom line of 21<sup>st</sup> century business*, (New Society Publishers; Stoney Creek, CT), 1997.
- 16 IFLA, *Libraries, Development and the United Nations 20030 Agenda*, (2020). Available at <https://www.ifla.org/libraries-development> (Accessed on 23 Mar 2022).
- 17 Fedorowicz-Kruszewska M, Sustainable libraries: fashion or necessity? *Italian Journal of Library, Archives and Information Science*, 10 (1) (2019) 92-101.
- 18 Kumar P S and Sofiya A, Application of green concepts in the libraries of Thiruvananthapuram: an investigation, *Library Philosophy and Practice*, (2019). Available at <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=6127&context=libphilprac> (Accessed on 24 Mar 2022).
- 19 Saha P and Padhan H, Green libraries effect to the academic institutions: a special study on US based libraries, *Library Philosophy and Practice*, (2019). Available at <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=5928&context=libphilprac> (Accessed on 16 Mar 2022).
- 20 Binks L, Braithwaite E, Hogarth L, Logan A and Wilson S, Tomorrow's green public library, *The Australian Library Journal*, 63 (4)(2014) 301-312.
- 21 Neuendorf K A, *The content analysis guidebook*. (Sage; London), 2017, p.84-92.
- 22 De Sarkar T, The prevalence of web browser extensions use in library services: an exploratory study, *The Electronic Library*, 33 (3) (2015) 334-354.
- 23 Latimer K, Collections to connections: changing spaces and new challenges in academic library buildings, *Library Trends*, 60 (1) (2011) 112-133.
- 24 Schopf J, Smart libraries, *Infrastructures*, 3 (4) (2018) 43.
- 25 Kruse T, Greener library printing and copying, *The Bottom Line*, 24 (3) (2011) 192-196. Available at <https://doi.org/10.1108/08880451111186053> (Accessed on 15 Dec 2021).
- 26 Gaffar S A, Sindhu P N and Kumar S K, The Green library Initiative in Indian perspective : a study, *Library Philosophy and Practice*, (2021). Available at <https://digitalcommons.unl.edu/libphilprac/6189/> (Accessed on 2 Apr 2022).
- 27 Bangar M S, Green libraries in India: an overview. In *National Conference on Transforming Libraries into Knowledge Resource Centres*, 2018, p. 222-230.

## Annexure 1 — List of academic libraries selected for the study

<b>Sl. No.</b>	<b>Name of the Academic Library</b>	<b>Name of the Country</b>
1	Australian National University	Australia
2	Boston University	United States
3	California Institute of Technology	United States
4	Carnegie Mellon University	United States
5	Chinese University of Hong Kong	Hong Kong
6	Columbia University	United States
7	Harvard University	United States
8	Hong Kong Polytechnic University	Hong Kong
9	Humboldt University of Berlin	Germany
10	Imperial College London	United Kingdom
11	Johns Hopkins University	United States
12	Kyoto University	Japan
13	Leiden University	Netherlands
14	London School of Economics and Political Science	United Kingdom
15	Massachusetts Institute of Technology	United States
16	Middle East Technical University	Turkey
17	National University of Singapore	Singapore
18	New York University	United States
19	NIT Silchar	India
20	Princeton University	United States
21	Seoul National University	South Korea
22	Stanford University	United States
23	Technical University of Munich	Germany
24	Tsinghua University	China
25	University of Amsterdam	Netherlands
26	University of British Columbia	Canada
27	University of California, Los Angeles	United States
28	University of Cambridge	United Kingdom
29	University of Canterbury	New Zealand
30	University of Chicago	United States
31	University of Edinburgh	United Kingdom
32	University of Hong Kong	Hong Kong
33	University of Illinois at Urbana-Champaign	United States
34	University of Manchester	United Kingdom
35	University of Melbourne	Australia
36	University of Oklahoma	United States
37	University of Otago	New Zealand
38	University of Oxford	United Kingdom
39	University of Pennsylvania	United States
40	University of Queensland	Australia
41	University of Stockholm	Sweden
42	University of Sydney	Australia
43	University of Tokyo	Japan
44	University of Toronto	Canada
45	University of Washington	United States
46	University of Wellington	New Zealand
47	Uppsala University Library	Sweden
48	Utrecht University	Netherlands
49	Washington University in St Louis	United States
50	Yale University	United States

## Annexure 2 — List of public libraries selected for the study

Sl. No.	Name of the Public Library	Name of the Country
1	Adams County Library	United States
2	Baker County Library	United States
3	Biblioteca Nacional de España	Spain
4	British Library	United Kingdom
5	Danish Royal Library, The National Library of Denmark and Copenhagen University Library	Denmark
6	Dewan Bahasa dan Pustaka Library	Brunei
7	Edmonton Green Library	United Kingdom
8	Fairfax county	United States
9	German National Library	Germany
10	Hong Kong Central Library	Hong Kong
11	King County Library	United States
12	Library and Archives Canada	Canada
13	Library of Congress	United States
14	Los Angeles Public Library	United States
15	National Archives of Zimbabwe Library	Zimbabwe
16	National Central Library (Florence)	Italy
17	National Diet Library	Japan
18	National Library "Miguel Obregon Lizano" of Costa Rica	Costa Rica
19	National Library of Antigua and Barbuda	Antigua and Barbuda
20	National Library of Australia	Australia
21	National Library of Bangladesh	Bangladesh
22	National Library of Brazil	Brazil
23	National Library of Chile	Chile
24	National Library of Colombia	Colombia
25	National Library of Finland	Finland
26	National Library of France	France
27	National Library of India	India
28	National Library of Korea	South Korea
29	National Library of Luxembourg	Luxembourg
30	National Library of Malta	Malta
31	National Library of Mexico	Mexico
32	National Library of New Zealand	New Zealand
33	National Library of Singapore	Singapore
34	National Library of the Argentine Republic	Argentina
35	National Library of the Czech Republic	Czech Republic
36	National Library of the Maldives	Maldives
37	National Library of the Philippines	Philippines
38	National Library of Wales	Wales
39	National Library Service of Kenya	Kenya
40	New York Public Library	United States
41	Orange County Library	United States
42	Queens Public Library	United States
43	Ridgeland Public Library	United States
44	Royal Library of Belgium	Belgium
45	Santa Monica Public Library	United States
46	Seattle Public Library	United States
47	State Library, New South Wales	Australia
48	Swiss National Library	Switzerland
49	Vatican Library	Vatican City
50	Williston Community Library	United States