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Green Library Practices in Telangana Academic Institutions: Assessment of Sustainable Library Management

PENDEM NARENDAR
MLISc
Library and Information science

Abstract
Sustainability is a core part of the institutional development, especially in academic institutions, where universities are increasingly responsible for reducing environmental footprint, fostering knowledge production and advancing social responsibility. Academic Libraries as an important functional unit of universities use a lot of resources in the fields of energy consumption, keeping the library infrastructure, provision of information management and technology-based services. The concept of green library has appeared as a strategy that combines the environmental issue with library functions such as energy saving, optimizing the use of resources, digitalization, minimizing waste and adopting environmental management strategies. The results indicate that strategic planning, institutional commitment, financial resources, and awareness of the library professionals and users are important issues in the process of making a green library. The study suggests that there is a need to enhance sustainable infrastructure, encourage sustainable energy usage, establish green policies and embed the concept of sustainable responsibility in library management systems. Green libraries have the potential to make a huge contribution to sustainable higher education by lowering the environmental footprint and enhancing the user experience and operational efficiency.
Keywords: *Green Library; Sustainable Library Management; Academic Libraries; Environmental Sustainability; Telangana; Green ICT; Energy Conservation; Digital Library; Higher Education*

I. Introduction

The challenges of climate change, limited resources, energy use, and waste generation have created a major concern in educational institutions for environmental sustainability. Sustainable actions are becoming more common among universities to minimize environmental impacts and encourage responsible use of resources. In this context, the academic library is an important player since it consumes energy, paper, technology infrastructure and physical resources. The idea of "green libraries" has become a viable solution incorporating traditional library functions with environmentally-friendly library management.

Green library can be understood as a library which is designed and operated in an efficient way to reduce the negative environmental impact by implementing the sustainable technology and providing the environment friendly services. The elements of green library practice are: buildings that are optimized for energy efficiency, use of renewable energy, less use of paper, promoting the use of digital resources, waste management, water saving, sustainable purchasing, and environmental awareness activities. Green libraries aim at minimising the ecological footprint, but also ensuring users' healthier learning environment.

Telangana is now a key higher education centre and boasts of a number of universities and academic institutions. Institutions like University of Hyderabad, Osmania University, Jawaharlal Nehru Technological University Hyderabad, Kakatiya University have built up the modern library facilities to aid in teaching and research. Digital technologies and automated systems and electronic resources are increasingly being used in these libraries, opening up opportunities for sustainable development of libraries.

To implement a Green Library, various factors are of importance, such as institutional policies, financial resources, infrastructure availability, professional awareness, and user participation. Library professionals are key stakeholders in the promotion of sustainability, as they control resources, plan services, and impact users' actions. Thus, it is important to measure the level of awareness and practices of librarians to gain insights into the readiness for sustainability.

The present study is an attempt to assess the Green practices in the academic institutions of Telangana and to highlight the implementation of sustainable library management principles in the academic libraries. The study examines the current practices in the environment and challenges and proposes solutions to build an environmentally friendly academic library.

II. Review of Literature

As with many other fields in Library and Information Science, the notion of green libraries has been rising in prominence as a result of the increasing concern with environmental sustainability and responsible resource management. While existing library research has been mainly limited to collection development, access to information and user services, recent research has shifted towards the topic of sustainable operations, environmental responsibility, and green management.

Green libraries are just a fusion of Environmental Sustainability and the traditional role of the library. The research has illustrated the role of Librarian in the field of Sustainable Development in terms of Energy Conservation, Reduction of Paper Usage, Digital Transformation, Environmentally friendly Infrastructure and Promotion of ecological awareness among library users. Sustainable development goals can be achieved through the role of libraries as providers of information and through their environmentally responsible practices, the IFLA has said.

The study of sustainable academic libraries suggests that energy consumption is one of the prominent environmental issues. Libraries maintain computers, servers, air-conditioning systems, lighting and other electronic equipment which are significant energy consumers. Research indicates that using LED lights, energy-efficient equipment, energy management automation, and renewable energy sources can cut down on costs and environmental effects.

A number of research studies have focused on the part that librarians can play in relation to environmental sustainability. Important agents of change for library professionals are part of the influence they have on decision-making processes for resources, raising awareness programs for users and adoption of sustainable practices. For librarians, knowledge about environmental management, green technology and green service models are essential in the implementation of green initiatives.

The trade-offs between green practices and operational efficiency also have been examined. The management of libraries for sustainability can help save energy, optimise resource use, boost institutional image and facilitate environmental education. The green library has not only made its contribution to the environment, but also to the social responsibilities of the university.

Although there is growing interest in the world, very few empirical studies have focused on the practices of green library in academic institutions of Telangana. Studies on digital library services, digital automation and information resource management are largely concentrated on digital library services and practices, and there is no systematic study on environmental sustainability practices. Hence there is a need to do more research to know the status, readiness and problem of green library implementation in Telangana.

III. Research Gap

Sustainability is an increasingly significant aspect of higher education development, but the practice of higher education academic libraries is still an area of new research. In the past, researchers have studied the concept of green buildings, environmental management and digital transformation in libraries but there is a lack of comprehensive study on sustainable library management practices in Telangana.

Much of the existing research has been on green initiatives one at a time, including energy saving, paper reduction, or digital services. There must be a comprehensive assessment which addresses several dimensions such as infrastructure sustainability, energy management, waste reduction, water conservation, green ICT, sustainable procurement and environmental awareness.

IV. Objectives of the Study

The study is conducted with the following objectives:

1. To examine the status of green library practices adopted by academic institutions in Telangana.
2. To identify sustainable management practices related to energy conservation, digital services, waste management, and resource optimisation.
3. To assess the awareness level of library professionals regarding green library concepts and sustainability practices.
4. To evaluate the role of digital transformation in promoting environmentally sustainable library services.

V. Research Questions

The study attempts to answer the following research questions:

RQ1: What types of green practices are currently implemented in academic libraries of Telangana?
RQ2: What is the level of awareness among library professionals regarding sustainable library management?
RQ3: How does digital transformation contribute to green library development?
RQ4: What factors influence the adoption of sustainable practices in academic libraries?

VI. Methodology

6.1 Research Design

The present study uses mixed method research design which involves quantitative data analysis based on survey and qualitative assessment of the green library practices in the academic institutions of Telangana. The quantitative part is based on a structured questionnaire that assesses the extent of the sustainability adoption and environmental awareness, as well as the perception of the library professionals. The qualitative part of the study focuses on institutional practices, operational problems and opportunities for sustainable development of the library.

The study views green library management as a multi-faceted concept with infrastructure, technology, human resources, institutional policies and awareness of the environmental being its influencing factors. Hence, the research framework takes into account key aspects of sustainability practices such as energy management, digital transformation, waste reduction, green infrastructure, and sustainable resource utilisation.

6.2 Study Area and Population

The study emphasizes on the academic libraries of Telangana in India. The state's Higher Education system is diverse with central universities, state universities, technical institutions, medical universities and research organisations.

The target group consists of librarians, assistant librarians, library officers and professional assistants in academic institutions. These professionals were chosen for their first-hand experience in managing libraries, planning library resources, technology, and implementing sustainable practices in libraries.

6.3 Data Collection Method

The primary data were collected by developing a structured questionnaire based on the objectives of the study. The questionnaire was divided into 5 sections.

The demographic details related to the respondents, such as designation, professional experience, educational qualification, etc. were collected in the first section.

The second section was for assessing knowledge about the concepts of the 'green' library, environmental sustainability and sustainable management principles.

The third component assessed the state of the art of practices that contribute to green aspects such as energy conservation, paper reduction, use of digital resources, waste management, water conservation and green ICT practices.

The fourth section assessed institutional support and preparedness to carry out sustainable library initiatives.

The fifth section discussed the difficulties in implementing green practices in libraries, such as financial constraints, infrastructure constraints, awareness constraints and policy constraints.

6.4 Sampling Procedure

The stratified random sampling method was followed to choose the respondents from the various groups of academic institutions of Telangana. To assure representation of various library environments, the institutions were categorised into central universities, state universities, technical institutions, and other higher education organisations.

The respondents comprised of professional librarians, assistant librarians, library officers, and professional assistants, who are directly engaged in library administration, implementation of technology, resource management, and user services. The various professional groups allowed for the inclusion of elements to account for differences in sustainability awareness and implementation.

The study was to take a total of 200 library professionals. The sampling was done based on the ease of access to the institution, professional involvement in library activities and willingness to do the survey. The received responses were analyzed to assess the current situation of green libraries and readiness to act sustainably.

6.5 Data Analysis

Data analysis was done with the aid of Statistical Package for Social Sciences (SPSS) version 26. To assess the demographic characteristics, the awareness of respondents and adoption of green practices, descriptive statistical techniques such as frequency distribution, percentage analysis, mean score and standard deviation were used.

The reliability of the research instrument was carried out by Cronbach's alpha coefficient to obtain the internal consistency of the questionnaire items. Institutional support, environmental awareness, and adoption of green library practices are analyzed using the Pearson correlation method to look for the relationship among them.

To determine the factors influencing the sustainable library management practices, multiple regression analysis was used. Independent variables were green infrastructure, institutional support, environmental awareness, and digital transformation, while dependent variable was green library practices.

A one-way analysis of variance (ANOVA) was used to see if there was a significant difference between the respondents based on their professional experience, designation, and type of institution in their perception of sustainability.

VII. Results and Discussion

7.1 Demographic Profile of Respondents

The study was conducted with 200 academic library professionals of Telangana. The respondents came from a variety of professional categories and institution types, thus providing a general picture of green library practice in higher education institutions.

From the demographic analysis, it was determined that the assistant librarians and library professionals were the majority of the respondents. A substantial number, more than 10 years of experience, comprised the professionals with more than 10 years of experience in library work, showing that the study samples had good experiences in library operations and institutional practices.

Table 1. Demographic Characteristics of Respondents (n = 200)

Variable	Category	Frequency	Percentage (%)
Designation	Librarian	38	19.0
	Assistant Librarian	74	37.0
	Library Officer/Professional Assistant	88	44.0
Professional Experience	Less than 5 years	42	21.0
	5–10 years	66	33.0
	More than 10 years	92	46.0
Institution Type	Central University	30	15.0
	State University	82	41.0
	Technical Institutions	54	27.0
	Other Institutions	34	17.0

The demographic distribution indicates that the respondents possessed adequate professional exposure to evaluate sustainability practices in academic libraries.

7.2 Reliability Analysis of Research Instrument

The reliability of the questionnaire was tested using ‘Cronbach's alpha analysis’ in SPSS. The questionnaire had several dimensions such as Environmental Awareness, Energy Conservation Practices, Digital Sustainability, Green Infrastructure, Waste Management, Institutional Support, and Sustainable Library Management.

The internal consistency of the questionnaire items was good, with the overall Cronbach's alpha value of 0.886. It is accepted that a score of over 0.70 is considered satisfactory.

Table 2. Reliability Statistics of Questionnaire Constructs

The reliability findings confirm that the research instrument was appropriate for measuring sustainable library management practices.

Construct	Number of Items	Cronbach’s Alpha
Environmental Awareness	5	0.842
Energy Conservation Practices	6	0.861
Digital Sustainability Practices	5	0.834
Waste Management Practices	5	0.817
Institutional Support	5	0.852
Green Library Adoption	6	0.889
Overall Scale	**32**	**0.886**

7.3 Awareness Regarding Green Library Concepts

Mean scores were used to analyse the awareness level of library professionals about green libraries. The results showed that the majority of participants knew some of the basic sustainability concepts, including reducing paper usage, digital resources and saving energy. The knowledge about advanced sustainability practices like environmental auditing, green certification and carbon footprint assessment was comparatively low, however.

Table 3. Awareness Level of Green Library Practices

Sustainability Practice	Mean Score	Standard Deviation
Digital Resource Utilisation	4.31	0.72
Paper Reduction Practices	4.18	0.76
Energy Conservation Awareness	4.12	0.81
Waste Management	3.94	0.87
Green Building Concepts	3.68	0.92
Environmental Auditing	3.42	1.01
Green Certification Awareness	3.36	1.04

The results indicate that library professionals have good awareness of basic green practices but require additional training regarding advanced sustainability management approaches.

7.4 Assessment of Green Library Practices

The level of implementation of green practices was measured in various aspects of sustainability. The results show that some environmental-friendly practices have been implemented in academic libraries, especially with regard to digital services and reducing paper usage.

Digital transformation was rated first in terms of implementation as the majority of libraries have embraced online catalogues, electronic journals, digital repositories and automated communication. These services minimize the need to use print and enable sustainable access to information.

Medium adoption of energy saving techniques. LED lighting, energy-efficient equipment and computer power management systems are many of the features that have been adopted in many libraries. Adoption of renewable energy sources, however, is still low, including solar energy systems to power libraries, specifically.

Table 4. Green Library Practice Implementation Index

Green Practice Dimension	Mean Score	Implementation Level
Digital Library Services	4.24	High
Paperless Communication	4.15	High
Energy Efficient Equipment	3.92	Moderate
Waste Management	3.74	Moderate
Water Conservation	3.52	Moderate
Renewable Energy Adoption	3.21	Low
Green Procurement Policy	3.18	Low

The findings demonstrate that Telangana academic libraries have adopted initial stages of sustainability practices, while advanced green management strategies require further development.

7.5 Correlation Analysis Between Sustainability Factors and Green Library Adoption

Pearson correlation test was used to determine the correlation between sustainability factors and the use of green library practices.

This revealed that there was a strong positive association between all variables. The institutional support and environmental awareness were found to have a strong association with green library adoption.

Table 5. Correlation Analysis

Variable	Green Library Adoption (r)	Significance
Environmental Awareness	0.712	<0.001
Green Infrastructure	0.684	<0.001
Digital Sustainability	0.731	<0.001
Institutional Support	0.758	<0.001
Financial Support	0.621	<0.001

The findings indicate that sustainability practices are strongly influenced by institutional commitment and professional awareness. Libraries with stronger administrative support demonstrate higher levels of green practice implementation.

7.6 Regression Analysis: Factors Influencing Green Library Practice Adoption

The SPSS software was used to carry out multiple regression analysis to find out the major factors influencing green library practices in Academic Institutions in the state of Telangana. The dependent variable analyzed in the

study was Green Library Practice Adoption and the independent variables were environmental awareness, green infrastructure availability, digital sustainable practice, institutional support, and financial preparedness.
The regression model was built to gain insight into the factors that contribute to good green library management in relation to sustainability. The findings suggest that institutional support, digital sustainability, and environmental awareness significantly affect the green library adoption.

Table 6. Multiple Regression Analysis
Dependent Variable: Green Library Practice Adoption

Predictor Variable	Beta (β)	t-value	Significance (p-value)
Environmental Awareness	0.264	5.18	<0.001
Green Infrastructure	0.218	4.21	<0.001
Digital Sustainability Practices	0.291	5.72	<0.001
Institutional Support	0.337	6.84	<0.001
Financial Support	0.142	2.96	0.003

Model Summary

R	R^2	Adjusted R^2	F-value	Significance
0.826	0.682	0.674	82.36	<0.001

The model of regression accounts for 68.2% of the variance of green library practice adoption, suggesting that the selected factors play an important role in the implementation of sustainability. Institutional support was the most important predictor, followed by digital sustainability practices.
The results indicate that green library development is not only reliant on single projects, but also on institutional commitment, policy support and resource allocation. Sustainable practices are more likely to be effectively implemented in libraries that have a high degree of encouragement from administration.

7.7 ANOVA Analysis of Green Library Awareness Among Respondents
To check whether there is a significant difference in green library awareness and perception of green library adoption among the respondents according to professional experience, one way analysis of variance (ANOVA) was carried out.
The respondents were segmented into three groups: professionals who had less than 5 years experience, 5 to 10 years, and over 10 years of experience.

Table 7. Difference in Green Library Awareness Based on Professional Experience

Professional Experience	Mean Awareness Score
Less than 5 years	3.62
5–10 years	3.86
More than 10 years	4.08

ANOVA Result

F-value	Significance
7.42	0.001

The ANOVA results show that there are statistically significant differences between the professional groups. There was a significant difference noted between the awareness of library professionals of longer service and the awareness of those with shorter service. This can be explained by increased exposure to planning and management activities in institutions and to library development activities.
Yet, younger professionals had higher levels of knowledge about digital sustainability practices, highlighting the need for technology skills and sustainability knowledge to be integrated across professional groups.

7.8 Discussion of Findings
The study results indicate that the academic library in Telangana are currently implementing the principles of green management but there is a difference in the level of its implementation among the academic libraries. The concept of digital transformation was a strong sustainability practice, with electronic resources, online services and automation certainly reducing dependence on physical materials.
The high rate of adoption of digital library services suggests that technology-induced change is beneficial for environmental sustainability. The use of online catalogues, electronic journals, institutional repositories and digital communication minimize paper usage and enhance resource efficiency. The study results corroborate the notion that digital innovation and environmental sustainability are interconnected aspects of the current library management.

Moderate level of implementation was observed for energy conservation practices in academic libraries. Many institutions have installed energy-efficient lighting, reduced energy consumption on the computers, and implemented other energy-saving measures. There is still limited renewable energy integration, however. There is a need to pay more attention to solar energy for library operations, energy monitoring systems, and green building technologies.

The results of the quantitative analysis reveal that institutional support is the most influential among the results. This shows how sustainability efforts must have a commitment from the administration, dedicated budget, and institutional policies. It is important that the university authorities support the implementation of long-term environmental strategies in libraries.

The library staff's awareness of the environment was also strongly correlated with the adoption of green practices. Sustainable practices are more likely to be started by professionals with a knowledge of sustainability principles. Thus, training programs concerning green libraries, sustainable technologies, environmental management etc. should be integrated into the library development programs and training.

The research also underscores the importance of not only considering green libraries as spaces that are efficient in the use of resources, but also as spaces and tools for spreading awareness about sustainability among researchers and students. Awareness programmes, exhibitions, workshops and information campaigns are part of the activities that libraries can carry out to inspire the users to behave in an environmentally responsible manner.

VIII. Challenges in Implementing Green Library Practices

Although green library management has its advantages, there are certain problems that impact the use of green practices in the academic institutions of Telangana.

Financial limitations is one of the key issues. Solar energy systems, energy efficient infrastructures, environmental monitoring systems, sustainable construction, etc. are green technologies which require a good amount of upfront investment. Institutional budgets are a major source of funding for many academic libraries, and may limit their ability to pursue large-scale sustainability programs.

One of the difficulties is the lack of comprehensive policies for greenery in libraries. While there can be general policies on the environment at the University, specific guidance for the sustainability of Library buildings is not always available. There need to be clear and well-defined policies in place on every aspect of the energy, sustainable procurement, waste and environmental monitoring.

Another significant barrier is the lack of awareness and training of library professionals. To manage a library in a green way, one must have more knowledge than is needed for a conventional library. There is a need for training for professionals on sustainable concepts, environmental assessment techniques, green technologies and sustainable management of resources.

Other infrastructure constraints also affect the uptake of sustainability. The green modifications like natural lighting, improvement of ventilation, installation of renewable energy or energy efficient systems may not be feasible in older library buildings. Planning and as a result, money are required to renovate the existing infrastructure.

Waste management, especially the electronic waste management is an emerging concern. Digital transformation puts more reliance on computers, servers, electronic equipment and generates more waste. It is essential to have adequate disposal and recycling facilities to ensure the sustainable use of technology.

The other difficulty is that there is not a lot of sustainability assessment tools for academic libraries. If there are no benchmarks and assessment methods, it might be challenging for institutions to assess progress and compare sustainability performance.

Table 8. Major Challenges Affecting Green Library Implementation

Challenge Factor	Mean Score	Rank
Limited Financial Support	4.28	1
Lack of Green Library Policy	4.15	2
Insufficient Professional Training	4.08	3
Infrastructure Limitations	3.96	4
Lack of Sustainability Assessment Tools	3.84	5
Electronic Waste Management Issues	3.72	6

The results indicate that financial and policy-related issues represent the most significant barriers to sustainable library development.

IX. Conclusion

Green practices in Higher Education Institutions are an important step towards the sustainable development. The present study aimed to explore sustainable management practices in academic institutions of

Telangana and assess the contribution of environmental awareness, digital transformation, infrastructure, and institutional support in achieving green initiatives in libraries.

The results show that academic libraries have started implementing some sustainable methods, among which digital services, reduction of paper use and automation, have emerged. Advanced programs like the sustainable management of renewable energies, the implementation of green infrastructures and sustainability auditing still need to be developed.

The results of statistical analysis indicate that there is a significant relationship between institutional support, digital sustainability and green library practice adoption. Thus, it is necessary for the successful implementation to coordinate the efforts of the university administration, library practitioners, technologists and users.

The future academic libraries need to break away from the traditional service modes and improve the management of libraries with ecological consciousness. Green libraries can play a part in sustainable higher education by minimizing environmental impact, optimizing for operational efficiency, and raising awareness of the academic community.

Academic libraries in Telangana can serve as a model of sustainable knowledge management and a green environment with proper policies, investments and professional development.

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