



Sustainable Library Equipment in the Green Library Movement: International Practices and Implications for Vietnam

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Abstract:

This article examines sustainable library equipment as an operational dimension of the green library movement, focusing on international practices and their applicability in Vietnam. Using documentary analysis and comparative synthesis, the study reviews academic literature, professional guidelines, and Vietnamese policy documents on library digital transformation and higher-education library standards. The findings identify four major trends: energy-efficient technical systems, human-centred lighting and interior equipment, low-carbon digital infrastructure, and life-cycle-based procurement. International experience shows that equipment sustainability depends not only on technological modernisation but also on environmental performance, user well-being, maintenance capacity, and institutional accountability. For Vietnam, sustainable equipment development is feasible but requires context-sensitive adaptation, clearer green procurement criteria, energy-performance indicators, e-waste management, and professional capacity building.

Keywords: sustainable library equipment; green libraries; digital transformation; green procurement; Vietnam

1. Introduction

Libraries are no longer assessed solely as repositories of knowledge or service-oriented cultural institutions. In the context of sustainable development, they are increasingly expected to operate as environmentally responsible public infrastructures. This expectation has brought renewed attention to the material and technological foundations of library services: lighting systems, furniture, cooling and ventilation equipment, RFID technologies, computers, servers, scanners, self-service machines, security systems, and other devices that structure the everyday functioning of libraries.

This article uses the term sustainable library equipment to refer to library-related physical and technological assets that are selected, used, maintained, and replaced according to principles of energy efficiency, resource conservation, durability, accessibility, user well-being, and environmental responsibility. The concept includes energy-efficient lighting, eco-friendly and modular furniture, low-energy digital devices, smart climate-control systems, RFID and automated circulation technologies with reduced operational impacts, and equipment designed for repair, reuse, or responsible disposal.

The significance of this topic lies in the fact that equipment is one of the most direct channels through which the idea of the green library becomes operational. A library may formally pursue sustainability, yet its environmental performance depends heavily on the equipment it uses and the way that equipment is governed. Lighting systems affect energy consumption and reading comfort. Furniture influences material use, spatial flexibility, accessibility, and replacement cycles. Digital and automated systems improve service efficiency but may also increase electricity demand, hardware dependency, and electronic waste if they are not managed through sustainability criteria.

In Vietnam, the issue is especially relevant because many libraries are undergoing modernisation and digital transformation. National policy has encouraged the development of digital library infrastructure and technology-enabled services toward 2025 and 2030 (Prime Minister of Vietnam, 2021). In higher education, library standards have also identified facilities and specialised equipment as essential components of library development (Ministry of

Education and Training of Vietnam, 2023). These conditions create an important opportunity to integrate sustainability into equipment planning rather than treating modernisation as a purely technological process.

However, the adoption of sustainable library equipment in Vietnam still requires deeper examination. The central question is not simply how libraries can acquire more advanced equipment, but how they can develop equipment systems that are environmentally efficient, financially viable, technically maintainable, and appropriate to local institutional conditions. Therefore, this article aims to analyse international trends in sustainable library equipment development and discuss their applicability in the Vietnamese context. By focusing on equipment as a concrete but often underexplored dimension of the green library movement, the study seeks to contribute to a more practical understanding of sustainability in library and information science.

2. Literature Review

Existing research on green libraries provides an important foundation for examining sustainable library equipment, although the topic has not yet been fully developed as an independent research focus. The first major strand of literature concerns the conceptual expansion of the green library. Earlier approaches tended to associate green libraries mainly with environmentally friendly buildings, natural lighting, reduced energy consumption, and ecological education. More recent discussions, however, define the green library as a broader institutional model that integrates sustainability into planning, services, infrastructure, management, user engagement, and professional practice (International Federation of Library Associations and Institutions [IFLA], 2025; Kamińska, 2024). This shift allows equipment to be considered not as a merely technical matter, but as part of the operational logic of sustainable libraries.

The second strand focuses on library facilities and environmental performance. Studies in this area emphasise that equipment-related systems, particularly lighting, ventilation, cooling, and building-control technologies, directly shape energy use and indoor environmental quality. Miao (2024) argues that sustainable library buildings require an optimisation approach that balances energy efficiency with occupant comfort under changing climatic conditions. Lin (2024) similarly demonstrates that lighting in public libraries should be managed through human-centred and integrative principles, linking energy performance with visual comfort, asset management, and user experience. These studies show that equipment sustainability cannot be measured only by technical efficiency; it must also include comfort, adaptability, maintenance, and long-term usability.

The third strand examines the environmental consequences of digitalisation. Digital technologies have become indispensable to modern libraries, particularly through digital repositories, RFID systems, automated borrowing and return, scanning devices, servers, cloud services, and networked user terminals. Nevertheless, digital transformation is not automatically sustainable. Adeyemi et al. (2024) note that information and communication technologies may increase the carbon footprint of academic libraries when their energy consumption, procurement, and disposal are not governed by explicit environmental criteria. This literature is important because it challenges the assumption that technological modernisation necessarily produces ecological benefits.

The fourth strand concerns life-cycle thinking and green procurement. From this perspective, sustainable equipment should be evaluated across its entire life span, including material sourcing, production, transportation, installation, energy consumption, maintenance, repairability, reuse, and end-of-life treatment. This approach corresponds with the wider orientation of the green library movement, which encourages libraries to model responsible consumption and sustainable public service (IFLA, 2025). Yet in many studies, equipment remains dispersed across discussions of buildings, technology, service innovation, and facilities management rather than being analysed as an integrated category of sustainability governance.

In Vietnam, policy documents provide an initial basis for applying international experience, but they do not yet constitute a comprehensive framework for sustainable library equipment. The national programme on library digital transformation creates a strategic foundation for digital infrastructure and technology-enabled services (Prime Minister of Vietnam, 2021). The regulation on higher-education library standards identifies facilities, specialised equipment, information resources, and management capacity as core elements of library development (Ministry of Education and Training of Vietnam, 2023). However, these documents give limited attention to green procurement, equipment life-cycle assessment, energy-performance indicators, or carbon-conscious digital governance.

Overall, the literature reveals a clear research gap. Green libraries, sustainable buildings, library digital transformation, and library standards have been widely discussed, but sustainable library equipment has not been sufficiently examined as a distinct and integrated object of analysis. This article addresses that gap by synthesising international practices and evaluating how sustainable equipment development may be adapted to Vietnam's institutional, technological, financial, and environmental conditions.

3. Case and Methodology

This study employs a qualitative approach based on documentary analysis and comparative synthesis. The research case is structured around two analytical levels: international practices in sustainable library equipment development and their potential application in the Vietnamese context. This design is appropriate because the article focuses on identifying trends, interpreting policy relevance, and assessing contextual adaptability rather than measuring the performance of a single library.

The international dimension is examined through recent studies and professional documents on green libraries, sustainable library buildings, human-centred lighting, digital infrastructure, and environmentally responsible library practices. These sources are used to identify major equipment-related trends, including energy-efficient lighting, low-carbon digital technologies, RFID and automated systems, eco-friendly furniture, smart climate-control devices, and life-cycle-based procurement.

The Vietnamese dimension is analysed through relevant policy documents, particularly the national programme on library digital transformation and the regulation on higher-education library standards. These documents provide the institutional basis for assessing whether international practices can be adapted to Vietnamese libraries.

The analysis follows three steps. First, the study identifies key international trends in sustainable library equipment. Second, it examines Vietnam's current policy and institutional conditions. Third, it compares the two to determine areas of applicability, limitations, and possible directions for implementation.

The assessment is organised around four criteria: environmental performance, technological feasibility, financial viability, and institutional capacity. This framework allows the article to avoid a mechanical transfer of international models and instead evaluate how sustainable library equipment can be developed realistically within Vietnam's library system.

4. Results & Analysis

The analysis indicates that sustainable library equipment is developing as a practical component of the green library movement rather than as a separate technical issue. International practices show that equipment sustainability is increasingly associated with energy performance, user well-being, digital responsibility, material durability, and life-cycle governance. In the Vietnamese context, these trends are applicable, but their implementation requires selective adaptation to local policy, financial capacity, technical conditions, and professional competence.

To clarify the relationship between international practices and their possible application in Vietnam, the findings are first synthesised in Table 1 and then developed through a context-sensitive analytical model.

Table 1. International Trends in Sustainable Library Equipment and Their Applicability in Vietnam

Sustainable equipment trend	International practices	Relevance to the green movement	to the library	Applicability in Vietnam
Energy-efficient lighting and climate-control systems	Libraries increasingly adopt LED lighting, occupancy sensors, efficient HVAC systems, smart meters, and zoning-based control to reduce energy use while maintaining indoor comfort.	Supports energy conservation, improves indoor environmental quality, and reduces operational emissions.		Highly applicable, especially in public and academic libraries where lighting and cooling account for significant operating costs. Initial priorities should include LED systems, efficient air-

			conditioning, and basic energy monitoring.
Human-centred lighting and interior equipment	Lighting and spatial equipment are designed according to specific user activities, such as reading, digital learning, group work, exhibition, and archival preservation.	Connects environmental performance with user comfort, accessibility, and service quality.	Applicable in renovated reading rooms, university libraries, children's libraries, and community learning spaces. It requires functional zoning and user-oriented design.
Low-carbon digital and automated infrastructure	RFID systems, self-service machines, scanners, servers, digital repositories, and cloud-based platforms are assessed not only by service efficiency but also by energy use, durability, interoperability, and e-waste implications.	Prevents digital transformation from generating hidden environmental burdens.	Applicable but requires stronger procurement criteria and equipment life-cycle management. Priority should be given to energy-efficient devices, shared infrastructure, and responsible e-waste treatment.
Eco-friendly and modular furniture	Libraries use recyclable, durable, repairable, and modular furniture to support flexible space use and reduce replacement frequency.	Reflects circular economy principles and responsible material consumption.	Highly feasible because it can be implemented gradually and may involve local suppliers. It is particularly relevant for libraries with limited renovation budgets.
Life-cycle-based procurement	Equipment is evaluated through total cost of ownership, maintenance requirements, repairability, energy consumption, expected lifespan, and disposal options.	Moves sustainability from symbolic commitment to measurable institutional practice.	Necessary but still underdeveloped. Vietnam needs clearer green procurement indicators for library equipment and stronger training for library managers.
Equipment monitoring and governance	Libraries use inventories, maintenance plans, energy audits, and environmental indicators to monitor equipment performance.	Ensures accountability, measurability, and continuous improvement in green library operations.	Applicable first in large public and university libraries, then expandable to smaller libraries through simplified audit tools.

Source: Author's compilation, 2026.

Table 1 shows that sustainable library equipment development should not be reduced to the acquisition of environmentally friendly devices. It involves a shift from equipment ownership to equipment governance. In this sense, the most relevant international experience for Vietnam lies not in the mechanical adoption of advanced technologies, but in the gradual establishment of sustainability criteria for selecting, using, maintaining, and replacing library equipment.

4.1. International practices: From technical modernisation to sustainable equipment governance

International experience reveals a clear movement from technical modernisation toward sustainability-oriented equipment governance. Earlier library development models often treated equipment investment as a matter of automation, service efficiency, and user convenience. More recent green library practices place equipment within a wider framework of environmental responsibility, institutional resilience, and public accountability. This shift is reflected in IFLA's green library initiatives, which emphasise sustainable buildings, environmentally responsible operations, community engagement, and practical tools for green library development (International Federation of

Library Associations and Institutions [IFLA], 2023, 2024, 2025a, 2025b; International Federation of Library Associations and Institutions, Environment, Sustainability and Libraries Section [IFLA ENSULIB], 2025).

This trend confirms that sustainable library equipment must be assessed beyond its immediate technical function. Lighting systems, cooling equipment, RFID devices, servers, scanners, self-service machines, shelving, and furniture should be evaluated in relation to energy consumption, durability, maintenance cost, user comfort, material origin, repairability, and end-of-life treatment. In this perspective, equipment becomes part of the operational logic of the green library rather than a neutral technical asset. Kamińska (2024) similarly shows that sustainability in library and information science has become a multidimensional field, extending across environmental, technological, organisational, and social dimensions.

4.2. Energy-efficient equipment and indoor environmental quality

The first major trend concerns equipment that directly affects energy consumption and indoor environmental quality. Lighting, cooling, ventilation, and building-control systems are central because libraries normally operate for long hours and require stable conditions for reading, learning, research, preservation, and community use.

International studies indicate that energy efficiency cannot be pursued separately from user comfort. Miao (2024) argues that sustainable library buildings require optimisation strategies that balance energy reduction with occupant comfort, especially under changing climatic conditions. This is particularly relevant to equipment planning because air-conditioning, ventilation, sensors, and control systems determine both energy demand and indoor environmental quality.

Lighting is another important area. Lin (2024) argues that public library lighting should be managed through human-centred and integrative principles. Sustainable lighting, therefore, does not merely mean replacing conventional lamps with LED systems. It also involves glare reduction, appropriate illumination levels, functional zoning, maintenance planning, and adaptation to different library activities. Reading rooms, children's spaces, digital-learning areas, exhibition zones, makerspaces, and archival areas require different lighting conditions.

For Vietnam, this trend has strong applicability. Due to climatic conditions and the intensive use of lighting and cooling in many library buildings, energy-efficient equipment can produce both environmental and economic benefits. However, implementation should begin with technically manageable solutions, such as LED lighting, occupancy sensors, natural-light integration, efficient air-conditioning, and basic energy monitoring. These measures are more realistic than immediately adopting complex smart-building systems that require higher investment and stronger technical maintenance capacity.

4.3. Digital equipment and the carbon challenge of library transformation

The second trend concerns the environmental implications of digital and automated library equipment. Digital repositories, RFID systems, self-service borrowing machines, scanners, servers, cloud platforms, security gates, and user terminals are now essential to modern library services. They improve access, reduce manual workload, support resource sharing, and expand service capacity. Nevertheless, digital transformation is not automatically sustainable.

Adeyemi et al. (2024) demonstrate that information and communication technologies may increase the carbon footprint of academic libraries if their energy consumption, procurement, and disposal are not governed through explicit environmental criteria. This finding challenges the assumption that digitalisation is inherently green. In practice, digital equipment may generate new environmental pressures through electricity use, hardware replacement, data storage, and electronic waste.

For Vietnam, this issue is especially important because digital transformation has become a national priority in the library sector. The national programme on library digital transformation to 2025, with orientation to 2030, provides a strategic basis for developing digital infrastructure, shared resources, and technology-enabled library services (Prime Minister of Vietnam, 2021). However, this policy direction should be accompanied by carbon-conscious technology governance. Libraries need to consider energy ratings, device longevity, interoperability, maintenance capacity, data-storage efficiency, and e-waste management when investing in digital equipment. RFID and automation systems should be adopted not only for speed and convenience, but also for long-term operational efficiency and resource saving.

4.4. Eco-friendly furniture, flexible spaces, and learning equipment

The third trend relates to furniture, shelving, spatial equipment, and learning technologies. Although these elements are sometimes viewed as less technologically significant than digital systems, they strongly influence the sustainability, accessibility, and usability of library spaces. Eco-friendly furniture involves recyclable or responsibly sourced materials, durable construction, modular design, repairability, and adaptability to changing service models.

Recent discussions on the future of libraries emphasise their role as social infrastructure, learning environments, and regenerative public spaces (Lehmann, 2024). This orientation requires equipment that can support individual reading, collaborative learning, exhibitions, community events, digital training, and creative work. The development of makerspaces in libraries also shows that equipment is increasingly linked to participatory learning, innovation, and user engagement (Skåland et al., 2024). However, such equipment should be planned carefully to avoid wasteful investment, underuse, and unnecessary technological duplication.

For Vietnam, eco-friendly and modular furniture is one of the most feasible areas of application. Many libraries need to improve reading spaces but face financial limitations. Instead of pursuing expensive and uniform renovation, libraries can prioritise durable, repairable, locally produced, and flexible furniture. This direction supports sustainability while remaining financially realistic. It also improves accessibility, spatial adaptability, and user experience.

4.5. Applicability in the Vietnamese context

The Vietnamese context presents both opportunities and constraints for sustainable library equipment development. On the opportunity side, existing policy frameworks already recognise the importance of digital infrastructure, facilities, specialised equipment, information resources, and library management. The national digital transformation programme creates a policy foundation for technology-enabled library services (Prime Minister of Vietnam, 2021). In higher education, the regulation on university library standards identifies facilities, specialised equipment, information resources, and management capacity as core elements of library development (Ministry of Education and Training of Vietnam, 2023).

However, these documents do not yet provide a comprehensive framework for sustainable library equipment. They create institutional conditions for modernisation, but give limited attention to green procurement, equipment life-cycle assessment, energy-performance indicators, carbon-conscious digital governance, and e-waste management. This means that Vietnam has an enabling policy environment, but still lacks operational instruments for translating sustainability into equipment planning.

Several constraints should be noted. First, equipment investment in many libraries may remain fragmented, depending on short-term projects or available institutional budgets. Second, procurement often prioritises initial price and technical specification rather than total cost of ownership, energy use, repairability, expected lifespan, and disposal. Third, professional capacity for evaluating equipment sustainability remains uneven. Fourth, many libraries lack systematic data on electricity consumption, equipment utilisation, maintenance costs, and replacement cycles. Without such data, sustainable equipment planning cannot be implemented in a measurable way.

Therefore, applying international practices in Vietnam requires selective adaptation. Advanced smart-building systems, large-scale automation, or complex carbon accounting tools may not be suitable for all libraries. More realistic priorities include energy-efficient lighting, efficient cooling systems, durable furniture, responsible digital equipment procurement, simple monitoring tools, and staff training in sustainable equipment management.

Figure 1. A Context-Sensitive Model for Developing Sustainable Library Equipment in Vietnam



Source: Author's compilation, 2026.

Figure 1 illustrates how international green library practices can be adapted to the Vietnamese context. The model begins with the identification of major sustainable equipment trends and then assesses them through four criteria: environmental performance, technological feasibility, financial viability, and institutional capacity. These criteria are necessary because international practices cannot be transferred mechanically. They must be filtered through Vietnam's policy framework, digital transformation agenda, higher-education library standards, budget conditions, maintenance capacity, and professional competence.

The model also indicates that sustainable library equipment development should be understood as a staged process. Vietnamese libraries may begin with low-cost and high-impact interventions, such as LED lighting, efficient cooling, modular furniture, and basic equipment inventories. More advanced practices, such as integrated smart systems, carbon monitoring, and life-cycle-based procurement, can be developed gradually as institutional capacity improves.

4.6. Synthesis of findings

Overall, the results show that sustainable library equipment development is an integrated process rather than a set of isolated technical upgrades. International practices demonstrate that the most important trend is not simply the adoption of new devices, but the establishment of sustainability-oriented principles for equipment selection, operation, maintenance, and replacement.

For Vietnam, the most applicable directions include: upgrading lighting and cooling systems to improve energy efficiency and user comfort; applying sustainability criteria to digital transformation; prioritising durable and modular furniture; introducing life-cycle thinking into procurement; and strengthening institutional capacity for equipment monitoring and maintenance. These directions are consistent with Vietnam's current policy orientation, but they require more specific technical indicators and governance mechanisms.

The findings confirm the central argument of this article: sustainable library equipment is a concrete and necessary dimension of the green library movement. It connects environmental responsibility with service quality, technological development, financial efficiency, and institutional resilience. In Vietnam, its successful development will depend not on the direct importation of international models, but on the careful adaptation of global practices to local policy, financial, technical, and professional conditions.

5. Conclusion

This article has examined sustainable library equipment as a concrete and operational dimension of the green library movement. The analysis shows that sustainable equipment is not limited to energy-saving devices or environmentally

friendly furniture. Rather, it includes a wider system of physical, technological, and managerial assets that must be selected, used, maintained, and replaced according to principles of energy efficiency, durability, accessibility, user well-being, resource conservation, and environmental responsibility. This understanding is consistent with recent green library approaches that place sustainability within library infrastructure, management, services, and institutional practice rather than treating it as a peripheral environmental activity (International Federation of Library Associations and Institutions, Environment, Sustainability and Libraries Section [IFLA ENSULIB], 2025; Kamińska, 2024).

International practices indicate that sustainable library equipment development is moving in four major directions. First, libraries are prioritising energy-efficient systems, especially lighting, cooling, ventilation, and building-control technologies. Second, equipment design is increasingly linked to user comfort, flexible learning spaces, accessibility, and human-centred service environments. Third, digital and automated infrastructure is being reassessed through its carbon implications, including electricity use, device replacement, data storage, and electronic waste. Fourth, life-cycle thinking and green procurement are becoming essential to ensure that equipment sustainability is measured beyond the point of purchase. These trends correspond with recent studies emphasising the need to balance energy performance, indoor environmental quality, user comfort, and sustainable technology governance in library development (Lin, 2024; Miao, 2024).

For Vietnam, the findings suggest that international experience is highly relevant but cannot be applied mechanically. Existing policy frameworks on library digital transformation and higher-education library standards provide an important foundation for equipment modernisation. However, these frameworks still need to be strengthened by clearer sustainability criteria, green procurement indicators, equipment life-cycle assessment, energy-performance monitoring, and carbon-conscious digital governance. Without these operational mechanisms, library modernisation may increase technological capacity while also creating higher energy demand, maintenance burdens, and environmental costs. This is particularly important because digital transformation can generate new environmental pressures when information technologies are not governed through explicit sustainability criteria (Adeyemi et al., 2024).

The most feasible direction for Vietnamese libraries is a staged and context-sensitive approach. In the short term, priority should be given to energy-efficient lighting, efficient cooling systems, durable and modular furniture, basic equipment inventories, and responsible digital procurement. In the medium and long term, libraries should develop integrated monitoring systems, life-cycle-based procurement procedures, e-waste management, and professional training in sustainable equipment governance. Such an approach would allow Vietnamese libraries to improve service quality while gradually reducing environmental impacts and long-term operating costs.

In conclusion, developing sustainable library equipment is not merely a technical upgrade. It is a strategic pathway through which libraries can translate the ideals of the green library movement into everyday institutional practice. For Vietnam, this requires the careful adaptation of international practices to local financial, technical, climatic, and organisational conditions. If implemented systematically, sustainable library equipment can contribute to greener library infrastructure, more inclusive user environments, more efficient public investment, and a more resilient knowledge system aligned with sustainable development goals.

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