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Sustainability Metrics in Library Facility Management

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Abstract - **Libraries are now expected to operate sustainably through energy efficiency, resource and energy use, and environmental stewardship in both buildings and service delivery. This paper presents a holistic framework of sustainability indicators developed for library facility management. It identifies key indicators across five areas of energy consumption, water use, indoor environmental quality (IEQ), waste management, and sustainable procurement of products. The research examines the current state of sustainability in public and academic libraries, and how sustainability performance is influenced by digital disruption, green building certification (LEED, BREEAM), and user behaviours. The sustainability indicators are examined through mixed methods that include a survey, facility audit, and performance dashboard to provide an evidence-based approach to improve sustainability. The findings demonstrate that while many libraries express interest in achieving energy efficiencies, few measure or integrate clear sustainability indicators into the daily management of their operations. A sustainability scorecard was developed with alignment to the United Nations Sustainable Development Goals (SDGs) and offers timely recommendations to decision-makers and library facilities managers as a way forward. The work creates a space to continue the discussion and action for libraries to continue their advancement towards sustainable libraries and would encourage library facilities to approach operational conversations and strategies using data to identify informed, evidence, and metric-based sustainability and facility decision-making that seeks a reasonable balance between environmental concerns, user comfort, and the resilience and adaptability of operations.**

Keywords: **Sustainability, Library Facility Management, Green Libraries, Energy Efficiency, Sustainability Metrics, SDGs, LEED Certification**

I. INTRODUCTION

1.1. The Need for Sustainable Libraries

The trend toward sustainable development at the worldwide level is not only related to industry, but also to the educational and public institutions, including libraries (Mathiasson, & Jochumsen, 2022). The role of a library, as a knowledge center for a variety of communities, carries the responsibility of a social imperative and can model environmental stewardship and operational sustainability (Lang et al., 2012). With the growing concern of climate change, overuse and depletion of natural resources, and environmental degradation, the "green library" ideal has emerged to promote the use of environmentally responsible practices in design, construction, and resource use, waste, and collection of community user services. Libraries are expected to provide user access to information, but are also expected to be models for sustainability within their community (Sacco, 2011). Libraries generally experience high user frequency and foot traffic along with high energy use and infrastructure utilization, presenting an opportunity for greater resource efficiency and sustainable initiatives (Manna & De Sarkar, 2022). As libraries transition to becoming sustainable libraries, they align their inherent social responsibility to the commitment made by the institutions to the United Nations Sustainable Development Goals (SDGs), such as Goal 11 (Sustainable Cities and Communities) and Goal 13 (Climate Action), and reimagine the management of their facilities (Rahim, 2024; Thorpe & Gunton, 2022).

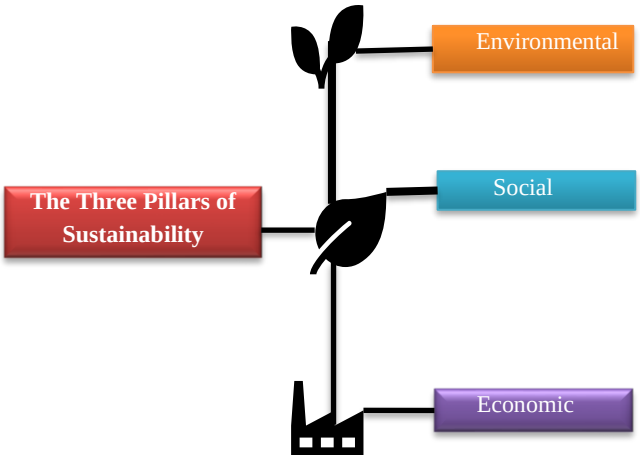


Fig. 1 Triple Bottom Line Framework for Sustainable Library Facility Management

Fig 1 illustrates that the triple Bottom Line Framework for Sustainable Library Facility Management shows the ways environmental, social, and economic aspects overlap in the context of sustainable library management and facilities (Ochôa & Pinto, 2014). The environmental aspects include energy use, water conservation, and waste reduction. Social aspects bring significant factors to accessibility, user comfort, and engagement with the community. Economic aspects include affordability, life-cycle management, and operational resilience. Overall, this framework encourages balanced and comprehensive consideration of sustainability in the operations of library facilities (Muralidharan, 2025).

1.2 Challenge in Facility Management

The challenges associated with managing library facilities all relate essentially to managing the people and collections in optimal environmental conditions (Lynch et al., 2023). Library facilities must consider thermal comfort, lighting, air quality, and accessibility while still being mindful of energy consumption and the allocated budget (Raghav & Sunita, 2024). Many libraries operate in existing facilities that are older, have outdated operational heating/cooling systems, and have inadequate insulation and lighting, which increases energy consumption and maintenance costs. The electronic needs of digital services have also shifted library reliance on electronic devices, and therefore the energy required to perform and sustain library services across those devices and systems (Das & Kapoor, 2024). In many cases, library facilities are challenged by limited funding, their older infrastructure, which isn't accommodating for the future, and a lack of designated trained sustainability officers that would advocate and enforce sustainability assessment and practices (Demirtas Dogan & Gurpinar, 2023). Libraries cover a broad spectrum of "types," including, but not limited to, academic and public, special, and archival libraries. This variety affects how the library can be managed for facilities and the needs for successfully operating the library under such types of priorities based on environmental aspects and operational goals. Therefore, it is seen as necessary, but also a challenge, to develop and utilize valid metrics of sustainability (Sharma & Maurya, 2024).

1.3. Sustainability Metrics: Definition and Context

Sustainability metrics are qualitative indicators that can be measured and relied upon for assessing, monitoring, and managing the environmental impact of library buildings and library-related activity. Many of the sustainability metrics include energy consumption per square meter, water consumption, indoor air quality, waste diversion, thermal comfort experience, and carbon footprint or measure (Aytac, 2019). The purpose of sustainability metrics is to evaluate qualitative sustainability goals and develop measurable and discernible performance indicators; thereby establishing well-defined performance levels for the library to work toward. Sustainability metrics can assist with benchmarking against other libraries, tracking performance for compliance with certification programs such as LEED and BREEAM, and providing certainty for library managers when planning the retrofitting of existing facilities, developing policies, and making operational decisions (Mendez & Esquivel, 2025). Furthermore, sustainability metrics require contextual goals, which consider the library's geography, function, and building dynamics. A solid sustainability metric framework not only seeks to improve operational efficiency, but it concurrently provides trust, transparency, and accountability for the library institution and invites engagement from stakeholders (Tribelhorn, 2023).

II. Literature Review

2.1. Sustainability in Academic and Public Libraries

Sustainability has become an important focus in academic and public libraries as organizations confront rising pressures to operate with an environmentally sustainable focus. Academic libraries are frequently found within universities that have adopted sustainability mandates and appear to be an implementation action away from sustainability through actions like green building, cutting paper consumption, and focusing on digital resources. Various initiatives have been adopted, from automated lighting, smart HVAC systems, and green procurement, all of which work to minimize ecological footprints and allow for high-quality user experiences. Public libraries are community cornerstones and have approached sustainability in both facility and programming - promoting energy-saving educational workshops, repair cafés, and circular economy programming (Tribelhorn, 2023). Either way, (Antonelli, 2008) and (Jankowska & Marcum's, 2010) work recognize that libraries are transitioning from being information providers to sustainability role models. However, most of these efforts have been sporadically undertaken and often lack consistent measures of success and do not have established ongoing assessment protocols that can present comparable data to inform decisions and develop long-term initiatives (Enang et al., 2024).

2.2. Current Green Certification Systems (LEED, WELL, BREEAM)

Green certification systems have created a systematic process for certifying the sustainability of buildings, including libraries. LEED (Leadership in Energy and Environmental Design) is one of the most commonly used systems and was created by the U.S. Green Building Council and includes measures for energy usage, water resources, indoor environmental quality, and materials (Kolawole & Oladokun, 2025). The WELL Building Standard specifically addresses the impact of the built environment on human health and well-being, so it is particularly relevant to library environments, such as public libraries, in which numerous individuals enter and exit, more so than some commercial enterprises. BREEAM (Building Research Establishment Environmental Assessment Method) is mostly used by the UK and Europe, and relies on extensive environmental assessments throughout design, construction, and operation. These certification systems provide clear assessment protocols, but many libraries with limited budgets, aging infrastructure, or a lack of administrative support are unable to reach certification requirements. Additionally, these certifications often do not address the unique functions of libraries, like the preservation of sensitive collections or the incorporation of digital infrastructure, which would imply customizing metrics that speak to their sustainability goals (Jafari & Shokrzadeh, 2016).

2.3. Metrics for Built Environment and Library Infrastructure

The development and use of sustainability metrics for the built environment is striking a better balance between qualitative and quantitative indicators. The quantitative sustainability metrics include energy use intensity (EUI), carbon emission rates, indoor air quality measurements, daylighting allowances, occupancy rates, and tolerable temperature factors (Rasheed et al., 2022). With library infrastructure, the context furthermore adds additional dimensions we must take into account related to climate-controlled archives, operating data servers, and public engagement areas. Helpful tools do exist, such as Energy Star Portfolio Manager, and ASHRAE guidelines and reporting metrics, but those tools, while helpful, need to be customized to library-like facilities. As an example, a university library that operates 24/7 has a very different set of energy benchmarks than a small-town public library with limited hours of operation. At the same time, new technologies are offering further granularity and real-time tracking of metrics through BIMS (Building Information Modeling), IoT (Internet of Things-enabled monitoring systems), and AI (Artificial Intelligence)-based predictive and maintenance intention (ResearchGate Contributor, 2025). There is still some cause for concern, as hardly any libraries developed and implemented the specific sustainability dashboards we envisioned, and the literature indicates that there is a disconnect between the intent of our environmental and sustainability metrics and the actions that we actually took.

2.4. Gaps in Existing Sustainability Assessment Practices

A review of sustainability assessments in the management of library facilities revealed gaps in practice. First, there were few agreed-upon metric frameworks that were library-specific, which resulted in inconsistency that made it hard to benchmark and compare (Ojha & Arora, 2024). Most libraries are using one or more of the generic building metrics that do not consider library operations such as user behaviors, circulation, and programmatic energy usage. Second, while libraries often evaluate environmental sustainability, there are also social and economic sustainability dimensions that are not discussed, such as inclusivity, accessibility, and life-cycle costing. Third, there is limited staff time and expertise for sustainability monitoring that can help inform future actions, especially in developing countries. Studies completed by (Elkington, 1997) and more recently by the IFLA (2019) found that while sustainability is an agreed-upon goal, the mechanisms and the commitments to implement these mechanisms were scattered. Finally, the user feedback and user behavior are not integrated into the sustainability assessment process, given strong evidence that occupant behaviors drive consumption of resources and environmental performance (Kamińska, 2024).

III. METHODOLOGY

3.1. Research Design: Mixed-Methods Research

This study is a mixed-methods research design that mixes quantitative and qualitative research to investigate the sustainability indicators, including usability metrics, of our library facility management. Since sustainability encompasses both physical, quantifiable environmental metrics, as well as user subjective experience, and institutional practices, it can be broad and often unwieldy. The mixed-methods research design is a good fit. Quantitative data, such as energy use, water use, and indoor environmental quality, provide factual information about the performance of the facility; while qualitative data, through interviews and surveys, provide context-specific understanding of user actions, administrative barriers, and guidance about policies. The concurrent triangulation design means that the different types of data complement each other for more legitimate and nuanced findings. The combination of quantitative and qualitative data leads to a more objective and holistic evidence-based sustainability scorecard, informed by the specificity of regularly executed duties in library operations (Subaveerapandiyan et al., 2022).

3.2. Sampling and Data Collection (Surveys, Audits, Interviews)

A purposive sampling strategy was also used to identify ten libraries, a range of academic, public, and special libraries in urban and semi-urban settings. Libraries were included based on a range of factors, including access, the library administration's willingness to cooperate with data collection, buildings that differed in types, and a diverse user population. In order to collect data, there was a combination

of three data collection instruments: structured facility audits, surveys of users and staff, and semi-structured interviews with facility managers. Facility audits examined physical space, energy systems, HVAC function, lighting, and waste management. Surveys of users and staff examined user perceptions of comfort, environmental awareness, and satisfaction with sustainability practices. Interviews considered the decision-making process, challenges to implementing green strategies, and perceptions of metric use. Using triangulation produced a rich dataset for metric development across different dimensions (Mylonas et al., 2019).

3.3. Metric Selection Criteria (Quantitative + Qualitative Indicators)

The library sustainability metrics were selected on the basis of three criteria: relevance, measurability, and applicability. To account for the various aspects of sustainability in facilities management, a multifaceted approach was taken, considering quantitative indicators and qualitative indicators (Saidani et al., 2019). Identified quantitative metrics involved quantifiable measures like Energy Use Intensity (EUI in kWh/m²), Water Use per Visitor (liters), CO_2 levels indoors (ppm), Lighting Power Density (W/m²), and Waste Diversion Rate (%). Qualitative metrics included measures of user comfort (subjective ratings), accessibility satisfaction, green practice involvement by staff, and level of policy integration. First, the metrics selected fell under either environmental, social, and economic sustainability to be able to relate the identified indicators to the three TBL pillars. Second, it was important to include indicators based on performance and perception indicators to ensure a holistic approach to the scorecard sustainability indicators (Tribelhorn, 2022).

3.4. Scorecard Scoring Framework

To transform the metrics into a usable tool, a scorecard scoring framework was established to aggregate the individual metric values into an overall sustainability index. Each metric was assigned a weight based on its relative importance, and this was developed from a literature search and consultations with experts. Targets were developed based on industry standards and green building best practices, including LEED and BREEAM criteria. For example, an EUI of <100 kWh/m²/year would have received a perfect score, while an EUI of>200 kWh/m²/year would have merited minimal scoring. Each library's performance was scored by taking a normalized score (0-5) so as to allow comparisons between optional metrics. For each library, there were sub-scores for each of the environmental, social, or economic categories, which were combined into a single sustainability score for the library. The scorecard was flexible and allowed libraries to add or modify indicators to address local priorities and needs, although the scorecard is still structured around a common framework for analyzing and evaluating sustainability.

3.5. Measures of Validation (Expert Review, Pilot Testing)

Validation of the intended metric and scorecards' reliability and validity was achieved by way of expert review and pilot testing. Five experts (sustainability officers, librarians, and green building consultants) convened to ensure that the selected metrics and associated weightings were clear, appropriate, and plausible. Feedback was incorporated into revised metric definitions, scoring thresholds, and data collection protocols. A pilot test was subsequently conducted in two participating libraries to assess the usability of scorecards in real-time facilities assessment. Then, pilot findings were compared against independent audit outcomes from the pilot test to evaluate consistency and reliability. User feedback on the ease of interpretation and perceived utility of each scorecard was gathered and incorporated. Based on this pilot phase, revisions of score transparency, clarity, and alignment with current data systems were implemented that validated the tool's ability to be used more broadly.

IV. Results And Discussion

4.1. Sustainability Metric Performance in Sample Libraries

The sustainability metrics audited in the ten sampled libraries revealed considerable variances in performance in the environmental, social, and economic realms. In terms of quantitative audits, four libraries were rated low for Energy Use Intensity (EUI) (i.e., <110 kWh/m²/year). In these scenarios, the libraries had LED lighting retrofits and utilized sensor-controlled lighting. However, three libraries with older libraries had associated EUIs of greater than 200 kWh/m²/year, which demonstrated the upper limit of age and potential energy inefficiency. Water use per visitor within the library ranged from 1.6 to 4.8 liters, with the highest per-person rates found amongst libraries that did not utilize sensor-controlled plumbing fixtures. Waste audits indicated that waste diversion from the landfill was low, with only two libraries boasting diversion rates higher than 60%, which essentially demonstrated the under-developed recycling practices of the libraries; and in terms of the social dimensions of sustainability, user comfort ratings were generally high among libraries with good natural ventilation and functional ergonomic furniture; and staff from libraries that had little communication about a clear green policy initiative were equivalent in not considering further engagement with sustainability initiatives.

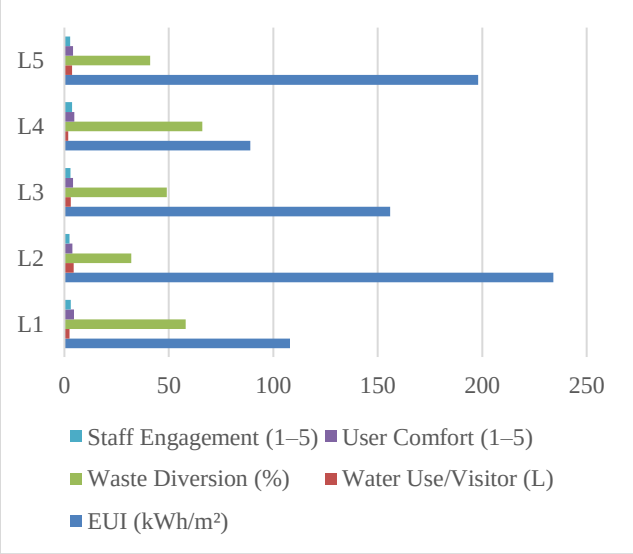
TABLE I COMPARATIVE PERFORMANCE OF SAMPLED LIBRARIES ON KEY SUSTAINABILITY METRICS

Library ID	EUI (kWh/m²)	Water Use/Visitor (L)	Waste Diversion (%)	User Comfort (1–5)	Staff Engagement (1–5)
L1	108	2.4	58	4.6	3.1
L2	234	4.5	32	3.8	2.5
L3	156	3.1	49	4.2	2.9
L4	89	1.9	66	4.8	3.7

Table I displays a multi-metric comparison of five libraries from the five sampled libraries aggregated across sustainability indicators: Energy Use Intensity (EUI), water use per visitor, waste diversion percentage, user comfort, ease, and staff engagement. Performance differences can be identified visually, as Library L4 demonstrates the strongest sustainability performance, based on its energy consumption at EUI (89 kWh/m²), user comfort at (4.8/5), and waste diversion (66%).

4.2. Benchmarking Against Green Building Standards

When compared with LEED and BREEAM performance thresholds, only two of the ten libraries satisfied the minimum criteria for energy and water efficiency. LEED recommends an EUI of below 100 kWh/m²/year for institutional buildings; Library L4 was the only library below this threshold. In BREEAM, the benchmarks for water use (2 liters/visitor/day) were only met by three libraries, before plumbing systems and visitor management showed inefficiency in only these three libraries. Indoor environmental quality (through CO_2 levels and daylight availability) was closer to green building standards in new libraries with open-plan layouts and sensor-driven ventilation. The comparisons in this section highlight that while a few libraries reach the criteria for green buildings for selected metrics, there are few libraries that could be described as green buildings, and that systemic non-compliance stems from legacy infrastructure and low appetite for investment in performance monitoring systems.



Graph. 1 Energy Use Intensity of Libraries Compared to LEED Compliance Threshold

Graph 1 illustrates that the libraries L2 and L5 exceeded that goal by a significant amount, due to obsolete energy systems, operational inefficiencies, understated energy use, and so forth. This comparison analysis accentuates the contrast between library performance and green building standards, suggesting the need for urgency with energy audits, retrofits, and sustainability certifications to improve facility lifecycle performance.

4.3. Digital Resources and Energy Consumption

The move to digital resources has two sides when it comes to sustainability performance. On the one hand, processing physical materials and travelling to and from a location have decreased exponentially when users switch to digital resources. On the other hand, a heavier reliance on server rooms, desktop stations, and the use of resources 24/7 comes with increased energy demands. Libraries with increased digital resource membership engagement (e.g., e-lending, online public access catalog access, digital learning terminals) showed an energy consumption increase of approximately 18%, primarily from server cooling and the greater operational hours of services in digital space, during a time when the entire sector of libraries faced transition during the recent pandemic. The positive note in consideration of the results actually comes from the libraries where digital services took a routine supporting digital resources model, with systems migrating to server virtualization and cloud-based resource management when comparing data, giving them up to 12% of relief in net impact. Much could be deduced from the mixed findings, indicating clearly that the move in digital space must be coupled and considered with backend energy efficiencies attached to migration and change to remain aligned with sustainability goals.

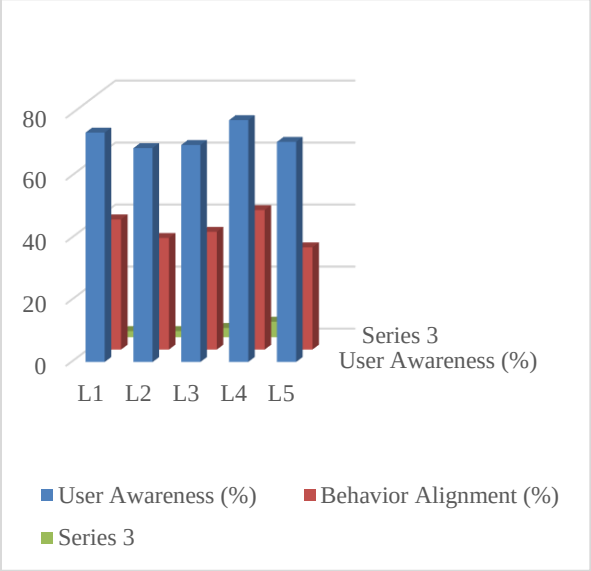
TABLE II RELATIONSHIP BETWEEN DIGITAL CIRCULATION, SERVER COOLING ENERGY, AND OVERALL ENERGY USE INTENSITY (EUI)

Library ID	% Digital Circulation	Server Cooling (kWh/mo)	EUI (kWh/m²/year)
L1	76%	780	108
L2	88%	1,300	234
L4	92%	670	89

Table II highlights the relation between the percentage of digital circulation services and resultant energy consumption for the server cooling and overall building performance. Libraries with significant digital usage, such as L2 and L4, display elevated server cooling energy demand as a consequence of increased computing demand, as well as 24/7 operating capabilities for digital infrastructures. However, L4 achieves an impressive energy-use intensity (EUI) of a low rate of 89 kWh/m²/year, while still utilizing a high level of digital consumption (92%), by implementing energy-saving server solutions such as virtualization and efficient direct cooling of their systems. As a comparison, L2 has high digital consumption, which directly relates to their high levels of server cooling energy (1,300 kWh/month) and overall inefficient energy use (EUI of 234, probably because they are not taking into account energy-saving actions at their server backend). As mentioned in Table II, it is accepted that digital resources increase access to information and reduce material waste and publishing/environmental footprint; however, it must be acknowledged that improved access to information cannot be fully realised without intentional backend efficiencies.

4.4. User Perspectives and Patterns of Behavior

Responses in surveys from greater than 300 users for the sampled libraries reflected users' positive perceptions of environmental conditions, including inputs such as air quality, natural lighting, and ergonomics of workspace and seating. Approximately 72% of users identified at least one of the sustainability initiatives occurring in their library (for example, paper recycling or solar panels). However, only 39% of users stated that they actively changed their behavior as a consequence of signage on a sustainability initiative or campaign. Qualitative comments suggest that with reminders and visually impactful forms of communication with respect to environmental impacts (e.g., dashboards of data, impact statistics with QR codes, and others), users were likely to adjust their behavior. Users were also very interested in making a contribution to green efforts if they could receive feedback on how their actions would contribute to resource savings, which would suggest further value in user-engaged sustainability dashboards.



Graph 2: Comparison of User Awareness and Behavioral Alignment Across Libraries

Graph 2 illustrates that the comparison of user awareness of sustainability related initiatives with user applied behaviour through the five libraries is illustrated in Graph 2. The data demonstrate the difference between user awareness and user applied behaviour across all five libraries, and particularly note the differences with the data that was collected on user awareness and their behaviours. For example, library L4 had the highest awareness level of 78% but only had 45% user alignment through behaviours such as recycling programs or energy-saving behaviours (e.g., turning lights off). In the same way, library L1 has 74% awareness but only 42% user alignment. Each of these libraries demonstrated a trend that reflects awareness does not equal sustainable behaviour for library users. Because there is a noted and clear gap, and these data ask libraries to better focus on engaging authentic and feedback communication by using real-time dashboards, campaigns, or rewards-based incentives to help narrow the intention–action gap and develop a user-run sustainability culture.

4.5. Uniting the Challenges of Adopting Sustainability Metrics

While there is increasing interest in sustainable operations, a variety of challenges prevent metrics from being established in libraries. First, many data collection systems were fragmented or not available; for example, HVAC systems did not have the embedded sensors that would allow for any meaningful, real-time performance extraction. Second, staff were not trained in sustainability reporting and received no performance incentives to go beyond basic custodial green practices. Third, library management software and building control systems were rarely interoperable and interconnected, so integrating a metric became impossible. Budget constraints prevented access to sophisticated audit tools and consultants; in addition, many library administrators struggled to justify investing in sustainability that didn't provide an immediate, visible, short-term return. The findings around library capacity underscore the need for open-source tools, toolkits, and in some cases, institutional mandates, to support libraries to operate sustainably as a fundamental operational parameter, rather than supplementary.

V. PROPOSED SUSTAINABILITY SCORECARD

In support of meaningful evaluation and ongoing development to facilitate Library Facility sustainability, the study has developed a formalized Sustainability Scorecard that highlights relevant performance measures in both environmental and user-focused domains. The scorecard is simple to use, scalable, and applicable for academic and public libraries to reliably assess, benchmark, and develop their sustainability efforts. The Scorecard is composed of five ontological areas measured in metrics selected because they are practical, can be quantifiably measured, and are related to the facility performance goals. The metric for Energy Efficiency is the total energy used, measured in kilowatt-hours per square meter (kWh/m²), totaling energy usage in relation to building size. Water Usage is measured in liters per day, considering the dispensations at specific areas of heavy use (washrooms). Indoor Air Quality is measured in carbon dioxide concentration (CO_2 ppm) levels, as this affects occupant health while aiming to use energy efficiently by making the most optimal energy use of the HVAC systems, within a particular area. Occupant Comfort is examined through user satisfaction ratings from consistent survey patterns asking about their satisfaction levels related to temperature, lighting, noise, and ergonomic comfort related to furniture choices (as applicable). Waste Diversion Rate (%) indicates the amount of waste that has been successfully recycled or composted as a percentage of total waste volume, as it relates to a library's commitment to reducing waste and following circular economy-style principles.

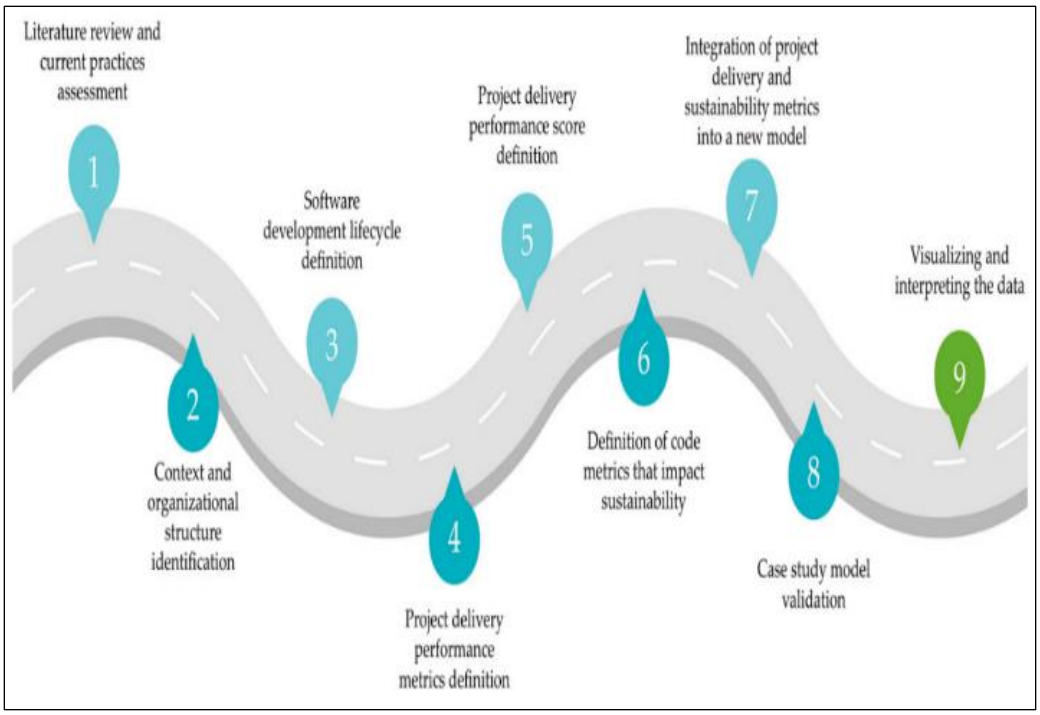


Fig. 2 Integration of Sustainability Metrics with Library Information Systems (LIS)

Fig 2 illustrates that this integration of Sustainability Metrics with Library Information Systems (LIS) demonstrates what a centralized dashboard could look like with real-time data from energy meters, air quality sensors, and user surveys. This system links Library Information Systems (LIS) with Building Management Systems (BMS), and each can integrate using an API, IoT connector, and web-based platform that can feed in what's happening now. This allows for automated tracking of sustainability KPIs such as energy usage, water usage, and waste diversion. It gives guidance based on data, and better decisions are made when data informs them and provides alerts when a facility achieves Lead rating, if needed. The setup would address contemporary issues about identity fractions of data, using the term in incremental, feasible metrics. The scorecard format consists of a series of tables, with each metric accompanied by a performance range (Excellent, Good, Needs Improvement), and a score (0-5 scale). The categories have benchmark (or target) information that is derived from green building standards such as LEED and BREEAM. The total score is then calculated based on the different categories and applying weightings to the score to determine a composite sustainability index for the facility. A sample template is described that provides columns for metric type, current value, benchmark, score, and recommendations for improvements. The scorecard will also be a helpful tool for internal auditing and sustainability reporting, where one is asked to provide evidence of their claimed processes.

In addition, the proposed scorecard is aligned with the United Nations Sustainable Development Goals (SDGs) and ISO 14001: Environmental Management Systems. Specifically, aligning with the Inc, not limited to SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Utilizing at least some principles of the ISO 14001 scorecard system, it encourages a proactive, policy-based approach to setting environmental objectives, compliance, and incorporates sustainability into everyday management decisions. To summarize, the Sustainability Scorecard is a typology that offers a unified framework, which reflects the mindset of sustainability from the 'idea' of sustainability in library services to the measurable framework of action in library facilities. The scorecard provides decision-makers with a tool to assess performance, define gaps, and set evidence-based improvement priorities against international benchmarks.

VI. Conclusion And Future Work

Over time, the practices of managing a library facility with sustainability in mind can be improved by formalizing and tracking sustainability metrics in library facility management, as we have demonstrated through the development of a multi-metric scorecard. The key takeaway of this research study is that many libraries have embarked on sustainability programs, and though many libraries have high-efficiency goods and water-saving devices, we have found inconsistent results in their sustainability practice, as many are one-off efforts. The scorecard we developed incorporates five main metric categories: energy, water, air quality, occupant comfort, and waste diversion to enable sustainable practices to more holistically address sustainability. Libraries that scored highest had a supporting administration committed to the sustainability initiative, had more recent build infrastructure, and worked to involve users. Benchmarking libraries against green building benchmark

standards, such as LEED, revealed that many libraries are performing below performance thresholds, particularly older libraries without automation and centralized monitoring. The insights derive some potential solutions for policy and design. At the policy level, library systems should integrate sustainability development goals as part of the forward planning and ongoing facility operations, aligned with staff training, and budgeted for retrofitting. As for a future library's development, librarians should consider environmental performance at the project's start, by embedding passive lighting systems, installing energy-efficient HVAC and low-flow water-use fixtures, and designing flexible spatial layouts to manage long-term energy reduction. In addition to passive energy efficiency, designers, librarians, and administrators responsible for the infrastructure portion of the library development should consider modular and expandable infrastructure to adapt to future changing community needs.

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