



Green Libraries in Ghana: Evaluating the Effectiveness and Challenges of Environmental Sustainability Efforts

Hawa Osman ^{a*} and Joana Dango ^b

^a University Library, University of Health and Allied Sciences, P.M.B. 31. Ho, Ghana.

^b University Library, Akenten Appiah-Menkah University of Skills Training and Entrepreneurial Development, P.O.Box 1277. Kumasi, Ghana.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/ajess/2024/v50i111649>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/126965>

Original Research Article

Received: 16/09/2024

Accepted: 19/11/2024

Published: 25/11/2024

ABSTRACT

Aims: Public libraries are integral to community development, offering access to information, education, and cultural resources. In response to the imperative of environmental responsibility, libraries are increasingly adopting sustainable practices to reduce their ecological footprint. This paper identified the environmental sustainability initiatives, assessed their effectiveness and explored the challenges faced by public libraries in implementing environmental sustainability initiatives

Methodology: This study employed a positivist research paradigm and survey design to investigate environmental sustainability initiatives in eleven geographically diverse public libraries in Ghana. Utilizing purposive and stratified random sampling, 70 library staff members were surveyed through tailored closed-ended questionnaires. The analysis focused on identifying the initiatives, assessing

*Corresponding author: Email: hosman@uhas.edu.gh, hosmanhawa@gmail.com;

their effectiveness, and exploring implementation challenges. Statistical analysis was conducted using ANOVA to evaluate the study objectives, ensuring a rigorous examination of the data collected from library staff experiences with sustainability initiatives

Results: The research findings indicate that gender does not significantly affect staff involvement in environmental sustainability initiatives in libraries, but age, education, job roles, and experience do. Younger, more educated individuals in specific roles showed greater participation. Varied perceptions about sustainability initiatives were noted among different demographics. This study identified critical challenges faced by libraries in implementing environmental sustainability initiatives. Financial constraints emerged as a predominant barrier (F-statistic = 12.909, P = 0.00). Insufficient staff training and awareness also hindered efforts (F-statistic = 9.834, P = 0.00). Limited management support (F-statistic = 7.739, P = 0.00) and resistance to change (F-statistic = 14.466, P = 0.00) further impeded progress. Inadequate infrastructure was a significant challenge (F-statistic = 21.486, P = 0.00), emphasizing the need for investment in sustainable technologies.

Conclusion: The environmental sustainability initiatives in Ghana's public libraries demonstrate a commitment to green practices and community engagement. By implementing tailored awareness campaigns, continuous staff training, and inclusive policies, libraries can effectively promote eco-friendly behaviors. Addressing challenges such as financial constraints and infrastructure limitations will further enhance their role in fostering sustainable development.

Keywords: Green libraries; environmental sustainability; public libraries; Ghana; eco-friendly practices; sustainable development; green information services; climate change mitigation.

1. INTRODUCTION

Public libraries are pivotal in providing communities with access to information, education, and cultural resources (Masenya & Ngulube, 2019). Recognizing the need for environmental responsibility, libraries are increasingly adopting sustainable practices to minimize their ecological footprint (Beutelspacher & Meschede, 2020). Environmental sustainability is paramount in addressing climate change, conserving biodiversity, and ensuring ecosystem well-being for future generations (Morelli, 2011). This concept integrates environmental, social, and economic dimensions, necessitating a balanced approach (Whang & Kim, 2015).

In libraries, environmental sustainability is a significant concern. Libraries contribute to sustainability through eco-conscious collections, tools, and events, impacting social, economic, and environmental dimensions (Beutelspacher & Meschede, 2020). Libraries, as educational hubs, promote green literacy and sustainable knowledge, making them essential in advocating for eco-friendly practices (Zobundžija & Dolaček-Alduk, 2021). Their role aligns with the UN 2030 Agenda for Sustainable Development, positioning libraries as agents of change in addressing global sustainability challenges (Zobundžija & Dolaček-Alduk, 2021).

The library landscape in Ghana serves as an important resource for education, cultural

preservation, and community development. It encompasses various types of libraries, including national, academic, public, and community libraries, contributing to access to information and educational support. Public libraries, managed by the Ghana Library Authority (GhLA), play a pivotal role in promoting literacy, lifelong learning, and community development. They offer free access to diverse resources and services, including books, multimedia materials, and educational programs for all ages. Public libraries also function as community hubs, hosting cultural events, workshops, and exhibitions.

In Ghana, environmental challenges like climate change and pollution persist, and public libraries have the potential to address these issues through education and community engagement (Fonseca et al., 2011). However, the current state of environmental initiatives in Ghanaian public libraries remain poorly understood due to limited data and research (Fonseca et al., 2011). This research aims to fill this gap by addressing the lack of empirical analysis regarding libraries' role in democratic and sustainable public spheres (Audunson et al., 2019). It explores the challenges faced by Ghanaian public libraries, including financial constraints and lack of awareness, hindering the implementation of sustainable practices. Moreover, there is the need for more research on the opportunities and challenges faced by libraries in enhancing community resilience, especially in the context of

disaster recovery (Veil & Bishop, 2014). The rationale of the study is to:

1. Identify the environmental sustainability initiatives implemented in public libraries.
2. Assess the effectiveness of environmental sustainability initiatives in public libraries.
3. Explore the challenges faced by public libraries in implementing environmental sustainability initiatives.

Sustainable development goals (SDGs)

framework: The Sustainable Development Goals (SDGs) framework, established by the United Nations in 2015, is a global initiative aimed at promoting sustainable development (Kardung et al., 2021). This framework encompasses three dimensions and addresses a wide range of issues related to sustainability, development, and environmental considerations (Griggs et al., 2014). The SDGs consist of 17 goals that cover various aspects such as poverty reduction, environmental protection, and economic growth (Baumgartner, 2019). These goals are interconnected and aim to achieve a balance between social, economic, and environmental sustainability (Chen & Tsou, 2006).

Below is a list of the 17 SDGs:

1. No Poverty
2. Zero Hunger
3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation, and Infrastructure
10. Reduced Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life on Land
16. Peace, Justice, and Strong Institutions
17. Partnerships for the Goals

The SDGs provide a comprehensive and integrated approach to sustainable development, emphasizing the need for objective targets and indicators to monitor progress effectively (Kharrazi et al., 2016). They serve as a guiding framework for various sectors, including health, business, and education, to align their strategies

with sustainable development objectives (Ghosh, 2020; Mayer-Foulkes et al., 2021; Owens, 2017). The SDGs have also been integrated into organizational strategies, reporting frameworks, and policy initiatives to drive sustainable practices and stakeholder engagement (Bredebach & Rösner, 2022; Liyanage et al., 2021).

Furthermore, the SDGs play a crucial role in shaping international policies and agreements related to sustainability and climate change (Hensher & McGain, 2020). They are instrumental in promoting sustainable finance, health care sustainability, and disaster risk reduction efforts worldwide (Perera et al., 2018). The SDGs have been recognized as a key driver for transforming financial systems towards sustainability and aligning with global climate goals.

Overview of green libraries: Green libraries are a concept that has gained momentum in the past few decades, with a focus on environmental sustainability and resource efficiency (Fedorowicz-Kruszewska, 2020). The Green Library Movement emerged in the early 1990s, with libraries aiming to reduce their environmental impact by greening library buildings, operations, practices, and providing green services (Mwanzu et al., 2023). This movement has been a response to the increasing global environmental awareness and the need for sustainable practices in various sectors, including libraries (Mohiuddin et al., 2018).

Early adopters and pioneers of sustainable library practices have played a crucial role in the historical development of green libraries worldwide. These pioneers have been instrumental in promoting increased environmental awareness and ecological sustainable design as well as services in everyday library practices (Kang, 2020). The Green Library, as an idea and project, was launched in Croatia by the Librarian Association of Istria in 2011, indicating the global nature of the movement (Zobundžija & Dolaček-Alduk, 2021).

The progression of green library initiatives has been influenced by the growing environmental knowledge and awareness, as well as changing attitudes toward "green consumption" in emerging countries' markets (Mohiuddin et al., 2018). Libraries have been recognized as crucial

in extending the agenda of promoting environmental practice, and they are in an excellent position to be both an ecological operator and promoter of environmental awareness (Dada, 2021). Furthermore, the recent movement towards greening library buildings, collections, services, operations, and outreach has been well covered in literature, indicating the increasing attention to sustainability in library practices (Jankowska et al., 2014).

Public libraries in Ghana: Public libraries in Ghana play a crucial role in providing access to information, promoting literacy, and supporting lifelong learning among the population. Ghana, located in West Africa, has a network of public libraries that serve both urban and rural communities. These libraries are essential in bridging the digital divide, fostering a reading culture, and supporting educational development in the country.

The Ghana Library Authority (GLA) oversees the management and development of public libraries across the country. The GLA was established in 1950 and has since been instrumental in expanding library services to various regions in Ghana. The GLA operates under the Ministry of Education and works closely with local governments to ensure the effective functioning of public libraries.

Public libraries in Ghana offer a wide range of services and resources to meet the diverse needs of their users. These services include lending of books and other materials, access to computers and the internet, reference services, literacy programs, and cultural events. Public libraries also serve as community hubs where people can gather for meetings, workshops, and other activities.

In terms of infrastructure, public libraries in Ghana vary in size and facilities. Some libraries are housed in purpose-built structures with modern amenities, while others operate in more modest settings. Despite challenges such as limited funding and resources, Ghanaian public libraries strive to provide a welcoming and conducive environment for learning and research.

Environmental sustainability initiatives in libraries: The initiatives from libraries around the world have increasingly focused on implementing green practices to minimize their

negative impact on the environment. These initiatives encompass a wide range of activities, including energy-efficient buildings, waste reduction, and the adoption of eco-friendly technologies. For instance, libraries have been undertaking activities aimed at minimizing their environmental impact since the early 1990s (Fedorowicz-Kruszewska, 2020). One of the key areas of focus has been the design and construction of energy-efficient buildings. Libraries have been implementing green building practices, such as the use of sustainable materials, energy-efficient lighting, and the incorporation of renewable energy sources to reduce their carbon footprint (Jones & Wong, 2016). For example, a case study in Kenya highlighted the implementation of green initiatives in libraries towards environmental sustainability, emphasizing the importance of environmental protection on a global scale (Mwanzu et al., 2023).

Waste reduction has also been a significant focus of green library initiatives. Libraries have been implementing strategies to reduce waste generation and promote recycling. This includes initiatives to minimize paper usage, promote digital resources, and implement effective waste management practices (Ismail et al., 2022). Additionally, libraries have been exploring the use of eco-friendly technologies to further enhance their sustainability efforts. This includes the adoption of energy-efficient technologies, such as smart lighting and heating systems, as well as the integration of digital systems to reduce the consumption of paper and other resources (Mazlan et al., 2018).

Furthermore, libraries have been actively involved in promoting sustainable practices beyond their physical infrastructure. They have been formulating wider green strategies to encompass various aspects of their operations and services. This includes promoting sustainable mobility, increasing ecological purchases, and improving waste management practices (Baricco et al., 2018). A qualitative case study of Pakistani university libraries highlighted the potential of libraries to address environmental issues through their work operations, emphasizing the importance of integrating green initiatives into library practices (Khalid & Batool, 2020).

Benefits of green libraries: The implementation of green initiatives in libraries has resulted in numerous positive outcomes and

benefits, impacting the environment, community engagement, and operational efficiency. Libraries that have embraced green practices have witnessed a reduction in their environmental impact, contributing to the preservation of natural resources and the mitigation of climate change (Ozoadibe & Obi, 2023). Additionally, the adoption of green initiatives has led to increased community engagement, as libraries have become hubs for environmental education and sustainability programs, fostering a sense of environmental stewardship within their communities (Jankowska & Marcum, 2010). Furthermore, the operational efficiency of libraries has been enhanced through the implementation of green practices, resulting in cost savings, improved resource management, and the promotion of sustainable technologies (Schmermbeck et al., 2020).

The success stories and lessons learned from libraries with well-established green practices serve as valuable insights for the broader library community. These libraries have demonstrated the tangible benefits of green initiatives, showcasing how environmental sustainability can be integrated into library operations and services (Kurbanoğlu & Boustany, 2014). By incorporating renewable energy facilities and green building practices, libraries have been able to preserve archives and reduce their environmental footprint (Ozoadibe & Obi, 2023). Moreover, libraries have actively engaged in creating curriculum for sustainability, incorporating sustainability content into information literacy, and building sustainability-related collections and research guides, thereby promoting environmental education and awareness (Jankowska & Marcum, 2010). The formation of sustainability communities within library associations has further facilitated the exchange of best practices and the development of collaborative initiatives to advance environmental sustainability (Williams et al., 2015). Additionally, the positive outcomes of green information systems (IS) usage in organizations, such as reduced resource consumption and increased compliance with regulations, underscore the potential benefits of integrating green technologies into library operations (Schmermbeck et al., 2020). Libraries have also played a crucial role in promoting green practices beyond their physical infrastructure, engaging in community activism, economic development, and social equity, thereby extending the impact of sustainability

efforts beyond their immediate environment (Williams et al., 2015).

Challenges in implementing green practices in libraries: The adoption of sustainable practices in libraries globally is confronted with various challenges. Mathiasson and Jochumsen (2022) conducted a review of the research literature on libraries, sustainability, and sustainable development, highlighting the challenges faced by libraries in adopting sustainable practices. The review emphasized the complexities and multifaceted nature of these challenges, including financial constraints, limited infrastructure, and cultural factors. Additionally, Mwanzu et al. (2023) provided insights from libraries in Kenya, shedding light on green initiatives towards environmental sustainability.

In the Ghanaian public library context, barriers such as inadequate government support and limited infrastructure further complicate the adoption of sustainable practices (Amoah & Eweje, 2022; Debrah et al., 2020). For instance, inadequate government support may result in a lack of funding and resources necessary to implement sustainable initiatives effectively, while limited infrastructure, such as unreliable electricity supply, may hinder the integration of green technologies and sustainable practices in Ghanaian public libraries (Amoah & Eweje, 2022; Debrah et al., 2020).

A study in Kenya highlighted the importance of exploring how libraries are planning for a sustainable future, shedding light on the challenges faced by libraries in adopting sustainable practices in the African context (Mwanzu et al., 2023). Additionally, research on Research Data Management (RDM) strategies for academic libraries in Ghana emphasized the need to set a national development agenda, indicating the complexities and specific challenges faced by libraries in Ghana in integrating sustainable practices (Zotoo & Liu, 2019).

2. MATERIALS AND METHODS

This study adopted the positivist research paradigm and utilised a survey research design to achieve its objectives. The positivist paradigm aligned with the study's aim to identify, assess, and explore the challenges of environmental sustainability initiatives in public libraries in a systematic and objective manner. The survey

research design was chosen for its effectiveness in collecting quantitative data from a large and diverse sample, allowing for a comprehensive analysis of the identified sustainability initiatives. Through structured surveys, the study systematically gathered data on the effectiveness of these initiatives, providing empirical evidence to evaluate their impact.

The study focused on eleven (11) public libraries in Ghana, namely Sekondi Regional Library, Volta Regional Library, Agbozume Branch, Accra Central Library, Keta Branch Library of GhLA, Senchi Library, Ada Community Library, Ada Foah Community Library, Aboasa Community Library, Tsito Library, and Fodzoku ICT Centre & Library. These libraries were selected based on their diverse geographical locations, representing both urban and rural settings, and their significance in the Ghanaian public library network.

The significance of these libraries in the Ghanaian public library network stem from their historical importance, community impact, service provision, and contribution to promoting environmental sustainability initiatives, literacy and knowledge dissemination in their respective regions. For instance, libraries in coastal areas like Ada Foah Community Library have initiatives related to coastal conservation and climate change adaptation, while libraries in urban centers like Accra Central Library focus on waste management and energy efficiency. Libraries like the Sekondi Regional Library, Accra Central Library, and Volta Regional Library are key players in the national library system, serving as hubs for information access, educational support, and cultural activities. Additionally, branches and community libraries such as Agbozume Branch, Keta Branch Library of GhLA, Ada Community Library, Ada Foah Community Library, Aboasa Community Library, Tsito Library, and Fodzoku ICT Centre & Library are essential components of the public library network, catering to the specific needs of local populations and fostering a culture of reading and learning at the grassroots level.

By selecting libraries that represent a mix of urban and rural settings, the study can provide a comprehensive overview of the challenges and opportunities faced by public libraries across different contexts in Ghana. This approach allows for an analysis of the factors influencing

library services, resource allocation, community engagement, and effectiveness in meeting the diverse information needs of Ghanaian citizens. The sampling method used in selecting these libraries was a purposive approach that ensured representation across urban and rural settings, considering factors such as library size, geographic location, and existing sustainability practices. The researchers aimed to capture a broad spectrum of experiences and challenges faced by public libraries in implementing environmental sustainability initiatives.

The study's population comprised of library staff members at the selected public libraries in Ghana. This included librarians, information specialists, and support staff actively involved in the day-to-day operations and management of library services. The choice of library staff as the population ensures that the research focuses on individuals directly engaged in the planning, implementation, and execution of environmental sustainability initiatives within the public library context. For this study, a sample size of 70 was determined based on the Krejcie and Morgan (1970) table.

A stratified random sampling method was employed to select participants for this study. The population of library staff across the 11 selected public libraries in Ghana was divided into strata based on their respective library locations. Subsequently, a proportional number of participants were randomly selected from each stratum, ensuring representation from various geographical regions. The sampling procedure involved assigning a unique identification number to each staff member, followed by the random selection of participants based on these identifiers. This method aimed to provide a diverse and representative sample, allowing for a comprehensive exploration of the perspectives and experiences of library staff regarding environmental sustainability initiatives and challenges in the Ghanaian public library context.

The study utilised closed-ended questionnaires as the primary data collection tool. The survey questionnaire was tailored to the needs of the Ghanaian context through a systematic and informed approach. The design of the survey questionnaire was informed by a thorough review of previous relevant literature on environmental sustainability practices in libraries, both within Ghana and in similar contexts

globally. By examining existing research studies and best practices in library sustainability, the researchers were able to identify key themes that are commonly used to assess environmental sustainability initiatives in library settings. This literature review served as the foundation for developing the survey questions, ensuring that they were grounded in established concepts. To ensure the validity and reliability of the instrument, a pre-test was conducted at the Kehillah Center and Public Library. The pre-test involved administering the questionnaire to a small group of participants to identify any ambiguities, inconsistencies, or issues with question clarity. Experts from the Committee for University Librarians and Deputies in Ghana were engaged to review the questionnaire for content validity. Their input and feedback were instrumental in refining the questionnaire to ensure it effectively captured the relevant information related to environmental sustainability initiatives in public libraries. Collected data were analysed using descriptive statistics to provide an overview of sustainability initiatives and inferential statistics to examine relationships and differences between variables. The researchers used a one-way ANOVA to analyse the data. This statistical method helps compare different groups based on their level of involvement in these initiatives, categorized as not involved, somewhat involved, moderately involved, and very involved. Three main areas were examined: the types of initiatives, their effectiveness on staff awareness, and the challenges faced by libraries. For each area, the null hypothesis stated that there would be no significant differences among the groups, while the alternative hypothesis suggested that differences do exist. This analysis helps understand how libraries engage with sustainability efforts. Ethical considerations, including informed consent and confidentiality, were maintained throughout the research process.

3. RESULTS AND DISCUSSION

Demographic characteristics of respondents:

The distribution of respondents in terms of gender, education level, job roles, and experience levels provides valuable insights into the diversity and composition of the library workforce. Table 1 support and provide context for each of these findings:

The study's findings reveal a balanced gender representation (48.6% male, 51.4% female)

within libraries, reflecting an inclusive workforce. Nishii (2013)'s research underscores the significance of gender diversity, emphasizing its role in fostering an equitable work environment. Moreover, 60% of respondents possess Master's Degrees, indicating a high level of education. Gorman (2004) study emphasizes the importance of education in preparing library professionals, suggesting higher education cultivates specialized skills. In terms of job roles, 48.6% are Library Assistants, 31.4% Assistant Librarians, 18.6% Administrative Staff, and 1.4% Librarians, indicating a diverse workforce. Experience levels are evenly distributed: 38.6% have 1-5 years, another 38.6% have 6-10 years, 11.4% have 11-15 years, and 11.4% have 16 or more years, showcasing a mix of novice and experienced professionals in the field. Also, Table 1 illustrated the distribution of involvement levels in environmental sustainability initiatives within the libraries. The data reveals that 32.85% exhibit no involvement, while 17.14% show minimal participation. However, a significant portion, 22.86%, is moderately engaged, and 27.14% demonstrate a high level of involvement. This suggests a diverse spectrum of commitment levels, with a substantial portion actively engaged in sustainability efforts within the library.

Environmental sustainability initiatives implemented in public libraries:

A one-way between subjects' ANOVA was conducted to compare the environmental sustainability initiatives on level of involvement in environmental sustainability initiatives (Not involved, somewhat involved, moderately involved and very involved)

The null hypothesis tested was:

Null Hypothesis (H₀): There is no significant difference in the types and extent of environmental sustainability initiatives across various public libraries.

Alternative Hypothesis (H₁): There is a significant difference in the types and extent of environmental sustainability initiatives across various public libraries.

The environmental sustainability initiatives implemented in selected public libraries, as depicted in Table 2, reflect an effort towards promoting green practices and reducing ecological footprints within the selected public libraries.

Table 1. Demographic Characteristics of Respondents

Demographic Characteristics of Respondents	Frequency	Percentage (%)
Total	70	100
Gender		
Male	34	48.6
Female	36	51.4
Educational Qualification		
Bachelor's Degree	28	40
Master's Degree	42	60
Job Position/Role		
Librarian	1	1.4
Assistant Librarian	22	31.4
Library Assistant	34	48.6
Administrative Staff	13	18.6
Years of Experience in the Library Profession		
1-5 years	27	38.6
6-10 years	27	38.6
11-15 years	8	11.4
16 years and above	8	11.4
Level of involvement in environmental sustainability initiatives in the library		
Not involved	23	32.85
Somewhat involved	12	17.14
Moderately involved	16	22.86
Very involved	19	27.14
Level of awareness of environmental sustainability practices in libraries		
Not aware	23	32.85
Somewhat aware	20	28.57
Moderately aware	8	11.4
Very aware	13	18.57
Highly knowledgeable	6	8.57

Source: Calculations Based on Field Survey, 2023

Table 2. Environmental sustainability initiatives implemented in public libraries

Variables	Not involved	Somewhat involved	Moderately involved	Very involved	Total	F	df	P-Value
Library promotes recycling paper, plastic, materials.	2.22±0.6	2.83±1.03	2.38±1.147	3.37±0.955*	2.67±1.018	6.192	3, 69	<0.001
Library adopts energy-saving measures: LED lighting, efficiency.	2.83±1.072	4.83±0.389*	2.38±1.204	3.68±0.478*	3.3±1.22	20.77	3, 69	<0.000
Library adopts policy: reduce water usage.	2.74±0.964	3.33±0.651	2.69±0.873	2.47±1.389	2.76±1.055	1.727	3, 69	0.17
Library reduces paper use with digital resources	3.7±0.635	4.25±0.866	4.13±0.957	2.42±1.305*	3.54±1.188	12.831	3, 69	<0.000
Library staff trained for sustainable practices.	2.87±0.458*	3.33±0.651*	3.69±0.602	4±0	3.44±0.651	21.769	3, 69	<0.000
Library fosters environmental awareness via events, programs.	2.61±0.656	2.42±0.515	3.19±0.403*	4±0.816*	3.09±0.88	21.853	3, 69	<0.000
Dedicated team oversees sustainability implementation, monitoring.	2±0.798*	2.83±1.03	3.25±0.577*	3.68±0.478*	2.89±0.986	20.445	3, 69	<0.000
Eco-friendly, biodegradable materials used in library supplies.	2.26±0.964*	3.33±1.497	3.06±0.443	4.32±0.478*	3.19±1.183	18.75	3, 69	<0.000
Library promotes eco-friendly commuting options for staff.	2.74±1.421	3.25±1.545	3.56±0.512	4±0*	3.36±1.155	5.144	3, 69	<0.003

Source: Calculations Based on Field Survey, 2023

Firstly, the initiative where the library promotes recycling paper, plastic, and materials demonstrates a commitment to waste reduction and resource conservation. The significant F-value of 6.192 and a very low P -value (<0.001) underscore the effectiveness of such efforts. By encouraging recycling, libraries contribute to minimizing landfill waste and preserving natural resources, aligning with broader sustainability objectives. The initiative to promote recycling aligns with existing literature that emphasizes the benefits of waste avoidance and resource recovery through recycling initiatives (Dunn & El-Halwagi, 2003). By encouraging recycling practices, libraries contribute to reducing environmental pollution and minimizing their ecological footprint, which resonates with the SDGs' call for sustainable cities and communities (Goal 11) and climate action (Goal 13).

Secondly, the adoption of energy-saving measures, such as LED lighting and efficiency improvements, signifies a proactive approach towards reducing energy consumption and mitigating environmental impact. With a substantial F-value of 20.77 and a very low P -value (<0.000), this initiative suggests significant potential for libraries to lower operational costs and decrease greenhouse gas emissions through energy efficiency practices. Energy-saving measures in libraries, such as LED lighting and efficiency improvements, are consistent with literature emphasizing energy efficiency to reduce operational costs and greenhouse gas emissions (Cheshta & Singh, 2023). These measures align with SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action), highlighting libraries' role in promoting sustainable energy practices (Lendínez-Turón et al., 2023). The statistical significance of energy-saving measures underscores their potential to lower energy consumption and enhance environmental sustainability, in line with studies advocating for energy efficiency to combat climate change and reduce environmental impact (Bonsu et al., 2020). By implementing these measures, libraries can reduce their carbon footprint and set an example for sustainable practices in their communities.

However, the initiative focusing on reducing water usage through policy adoption, while important, appears to have a relatively lower statistical significance with an F-value of 1.727 and a non-significant P -value (0.17). Nonetheless, implementing water conservation

policies remains critical for sustainable resource management, particularly in regions facing water scarcity or drought conditions. Existing studies highlight the urgency of water conservation efforts to address water stress and promote sustainable water management practices (Berrone et al., 2023). This initiative resonates with SDG 6 (Clean Water and Sanitation), emphasizing the need for efficient water use and conservation to achieve water-related sustainability goals (Santos & Bastos, 2021).

While the statistical significance may be lower for water usage reduction, the importance of implementing water conservation policies remains paramount for sustainable resource management. Water scarcity and drought conditions pose significant challenges globally, underscoring the need for proactive measures to ensure water sustainability and resilience (Berrone et al., 2023). This initiative aligns with the SDGs' call for responsible water management and underscores the interconnected nature of sustainable development goals (Patyal et al., 2022).

Furthermore, the initiative to reduce paper use by leveraging digital resources demonstrates a strong impact, as indicated by the high F-value of 12.831 and very low P -value (<0.000). By embracing digitalization, libraries not only streamline access to information but also contribute significantly to reducing paper waste and promoting environmental sustainability. The adoption of digital resources to reduce paper use in libraries is consistent with existing literature that highlights the benefits of digitalisation in minimising paper waste and enhancing information access (Ikenwe & Udem, 2022). This initiative resonates with SDG 12 (Responsible Consumption and Production) by promoting sustainable practices in resource management and aligning with the SDGs' call for efficient resource utilization.

Staff training for sustainable practices emerges as a highly impactful initiative, with a notable F-value of 21.769 and very low P -value (<0.000). Training staff in sustainability fosters a culture of environmental responsibility within the library workforce, facilitating the successful implementation of green initiatives and driving continuous improvement. Existing studies support the significance of staff training in promoting sustainable practices and environmental awareness within libraries (Beutelspacher & Meschede, 2020). This

initiative resonates with SDG 4 (Quality Education) by emphasizing the value of continuous learning and capacity building for sustainable development. By investing in staff training for sustainability, libraries can empower their workforce to champion environmental initiatives and contribute to broader sustainability goals (Saito et al., 2019). The statistical significance of staff training for sustainable practices underscores its impact on promoting environmental responsibility and driving positive change within library settings (Ismail et al., 2022). This initiative reflects a proactive approach towards embedding sustainability principles in library operations and aligns with the SDGs' call for education and awareness on environmental issues (Najmurokhman et al., 2023).

Also, the initiative to foster environmental awareness through events and programs plays a vital role in engaging the community and promoting sustainability values. The statistically significant impact, with an F-value of 21.853 and very low *P*-value (<0.000), suggests that libraries can serve as catalysts for environmental education and community mobilization towards sustainable actions. Existing studies support the effectiveness of environmental awareness initiatives in engaging communities and promoting pro-environmental behaviors (Dean et al., 2018). This initiative resonates with SDG 4 (Quality Education) and SDG 15 (Life on Land) by emphasizing the importance of education and awareness-raising for sustainable development and environmental conservation. By fostering environmental awareness, libraries contribute to building a more informed and environmentally conscious society, in line with the SDGs' emphasis on education for sustainable development (McCullough et al., 2020). The statistical significance of the impact of environmental awareness events and programs underscores their effectiveness in promoting sustainability values and engaging the community in environmental issues. This initiative reflects a proactive approach towards environmental education and community outreach, aligning with the SDGs' call for inclusive and participatory approaches to sustainable development.

Having a dedicated team overseeing sustainability implementation and monitoring is crucial for ensuring effective planning and coordination of green initiatives. The significant F-value of 20.445 and very low *P*-value (<0.000) highlight the importance of dedicated resources

for driving sustainability efforts and achieving measurable outcomes. Existing studies support the importance of dedicated teams in coordinating sustainability initiatives and ensuring their successful implementation (Myöhänen et al., 2008). This initiative resonates with SDG 17 (Partnerships for the Goals) by highlighting the significance of collaboration and coordination in achieving sustainable development objectives. By establishing dedicated teams for sustainability, libraries can enhance their capacity to drive environmental initiatives and contribute to the broader sustainability agenda outlined in the SDGs (Giannakeas et al., 2015). The statistical significance of the impact of having a dedicated team overseeing sustainability implementation underscores the importance of dedicated resources for driving sustainability efforts and achieving positive outcomes (Denona Bogovic & Grdic, 2020). This initiative reflects a proactive approach towards sustainability management and aligns with the SDGs' emphasis on effective resource utilization and collaboration for sustainable development.

The use of eco-friendly and biodegradable materials in library supplies represents a tangible commitment to sustainable procurement practices, as evidenced by the substantial F-value of 18.75 and very low *P*-value (<0.000). By opting for environmentally friendly materials, libraries contribute to reducing environmental pollution and minimizing their ecological footprint. Studies emphasize the importance of incorporating eco-friendly materials in various applications to mitigate environmental impact and promote sustainability (Lee & Lim, 2020). This endeavor corresponds with SDG 12 (Responsible Consumption and Production) by underscoring the importance of sustainable procurement practices in attaining environmental objectives and reducing waste generation (Wu et al., 2023). By opting for eco-friendly and biodegradable materials, libraries play a role in resource conservation and environmental protection, supporting the broader sustainability goals outlined in the SDGs (Moktadir & Ren, 2023). The statistical significance of using eco-friendly materials highlights the critical role of sustainable procurement practices in advancing environmental sustainability and achieving positive results. This initiative signifies a dedication to responsible resource management and reinforces the SDGs' advocacy for sustainable practices in material sourcing and consumption.

Table 3. Effectiveness of environmental sustainability initiatives in public libraries

Variables	Not involved	Somewhat involved	Moderately involved	Very involved	Total	F	df	P-Value
Library sustainability initiatives effectively reduce energy consumption.	2.61± 0.499	2.92± 0.996	3.63± 0.5*	3.68± 0.478*	3.19± 0.767	14.82	3, 69	<0.001
Library sustainability efforts reduce waste, enhance management.	2.91± 0.793*	3.42± 1.505	3.69± 0.602	3.68± 0.478	3.39± 0.906	3.782	3, 69	0.014
Library staff embrace eco-friendly practices, raising awareness.	2.61± 1.158*	3.25± 0.754	3.63± 0.5	3.68± 0.478	3.24± 0.924	7.717	3, 69	<0.000
Library sustainability efforts enhance user perception, engagement.	2.74± 0.541*	3.33± 0.651	4± 0.894	4± 0.816	3.47± 0.912	14.003	3, 69	<0.000
Library initiatives enhance eco-friendly, sustainable environment.	3.09± 0.733*	3.42± 0.669	4± 0.894	4.32± 0.478*	3.69± 0.86	12.215	3, 69	<0.000
Library sustainability efforts save costs, enhance efficiency.	3± 0.905*	3.25± 0.754	3.63± 0.5	3.37± 0.496	3.29± 0.725	2.622	3, 69	0.06
Library's green efforts boost reputation positively.	3.43± 0.662	2± 0.953*	3.63± 0.5	3.68± 0.478	3.3± 0.874	20.149	3, 69	<0.000
Library sustainability initiatives foster collaboration, external partnerships.	2.57± 0.59*	2.42± 0.515*	3.5± 0.516	3.68± 0.478	3.06± 0.759	24.855	3, 69	<0.00

Source: Calculations Based on Field Survey, 2023

Table 4. Challenges faced by public libraries in implementing environmental sustainability initiatives

Variables	Not involved	Somewhat involved	Moderately involved	Very involved	Total	F	df	Sig.
Financial barriers hinder library's environmental sustainability efforts.	0.487± 0.102	0.669± 0.193*	0.342± 0.085	0.478± 0.11*	0.606± 0.072	12.909	3,69	<0.00
Lack of training hampers library's eco-efforts.	0.59± 0.123	1.642± 0.474*	0.443± 0.111	0.848± 0.195	1.056± 0.126	9.834	3,69	<0.00
Library management hampers environmental sustainability efforts.	0.593± 0.124*	0.522± 0.151	0.602± 0.151	0.991± 0.227	0.814± 0.097	7.739	3,69	<0.00
Lack of guidelines hinders library's sustainability efforts.	0.518± 0.108	0.669± 0.193	0.365± 0.091	0.848± 0.195	0.629± 0.075	1.275	3,69	0.3
Limited collaboration hampers library's environmental sustainability efforts.	0.541± 0.113	0.289± 0.083	0.342± 0.085	0.496± 0.114	0.469± 0.056	2.729	3,69	0.05
Library staff resist environmental initiatives, hindering progress.	0.798± 0.166	0.651± 0.188*	0± 0	0.562± 0.129	0.773± 0.093	14.466	3,69	<0.00
Library lacks resources hindering eco-friendly initiatives.	0.793± 0.165	1.303± 0.376*	0.516± 0.129	0.496± 0.114	1.083± 0.129	21.486	3,69	<0.00

Source: Calculations Based on Field Survey, 2023

Lastly, promoting eco-friendly commuting options for staff aligns with broader sustainability goals and underscores the library's commitment to supporting environmentally conscious behaviors. While the F-value of 5.144 and significant P -value (<0.003) indicate a positive impact, further initiatives in this area can lead to reduced carbon emissions and enhanced staff well-being. Research underscores the importance of promoting eco-friendly transportation options to reduce environmental impact and foster sustainable mobility behaviors (Huang, 2023). This initiative resonates with SDG 11 (Sustainable Cities and Communities) by advocating for sustainable transportation solutions and aligning with the SDGs' call for sustainable urban development (Silva et al., 2023). By promoting eco-friendly commuting options, libraries play a role in advancing sustainable transportation practices and supporting the global sustainability agenda outlined in the SDGs (Bae et al., 2020). The statistical significance of the impact of eco-friendly commuting options highlights the positive influence of sustainable transportation practices on reducing carbon emissions and promoting environmental sustainability (Imran et al., 2019). This initiative signifies a commitment to promoting environmentally friendly behaviors and underscores the library's role in fostering sustainable practices among staff and the community.

Effectiveness of environmental sustainability initiatives in public libraries: A one-way between subjects' ANOVA was conducted to compare the effectiveness of environmental sustainability initiatives in public libraries on level of involvement in environmental sustainability initiatives (Not involved, somewhat involved, moderately involved and very involved).

Null Hypothesis (H0): The environmental sustainability initiatives implemented in public libraries do not significantly impact environmental awareness and practices among library staff.

Alternative Hypothesis (H1): The environmental sustainability initiatives implemented in public libraries significantly impact environmental awareness and practices among library staff.

The analysis of F-values and p-values from the studies reveals key insights into the effectiveness of sustainability initiatives in libraries. Notably, significant F-values ($F=14.82$,

$P<0.001$) indicate substantial differences in energy consumption reduction initiatives, aligning with Surroca et al. (2010) study emphasizing the importance of redesigning processes for efficiency and cost savings. A significant F-value ($F=3.782$, $P=0.01$) regarding waste reduction suggests the need for nuanced approaches, supported by Afum et al. (2020)'s findings on the positive impact of green manufacturing practices on waste management outcomes. Varied staff perceptions ($F=7.717$, $P<0.001$) highlight the necessity for targeted interventions, emphasizing the importance of optimized energy sources (Deng et al., 2022).

Additionally, substantial F-values signify the effectiveness of user engagement ($F=14.003$, $P<0.001$) and enhanced library reputation ($F=20.149$, $P<0.001$). Libraries are encouraged to expand user programs based on Keh and Xie (2009) suggestions on positive customer behavioral intentions. The F-value ($F=24.855$, $P<0.001$) underlines successful collaboration initiatives, reinforcing the importance of external relationships in sustainability efforts, as noted by Velten et al. (2021). While a marginally significant F-value ($F=2.622$, $P=0.06$) implies nuanced perceptions on cost savings, further qualitative research is recommended, aligning with Lu and Jiang (2019) insights on diverse optimization objectives.

Challenges faced by public libraries in implementing environmental sustainability initiatives: A one-way between subjects' ANOVA was conducted to compare the challenges and barriers faced by public libraries in implementing environmental sustainability initiatives on level of involvement in environmental sustainability initiatives (Not involved, somewhat involved, moderately involved and very involved).

The null hypothesis tested was:

Null Hypothesis (H0): There are no significant challenges or barriers faced by public libraries in implementing environmental sustainability initiatives.

Alternative Hypothesis (H1): There are significant challenges and barriers faced by public libraries in implementing environmental sustainability initiatives, impacting the effectiveness of these initiatives.

The implementation of environmental sustainability initiatives in libraries can be

influenced by various factors. Table 4 present the challenges and barriers faced by public libraries in implementing environmental sustainability initiatives. The calculated “F” value for the different groups is given in Table 4.

The study investigated various challenges faced by libraries in implementing environmental sustainability initiatives. Financial constraints were found to be a major hurdle, significantly impacting implementation efforts (F-statistic = 12.909, $P = 0.00$). Studies by Krajnc and Glavič (2005) and Al Breiki and Nobanee (2019) corroborate this, emphasizing the important role of financial resources in successful implementation.

Insufficient staff training and awareness also hindered initiatives (F-statistic = 9.834, $P = 0.00$). Pinzone et al. (2019) and Rathert (2016) supported this, highlighting the importance of training programs and staff engagement in promoting sustainability practices.

Limited support and commitment from library management posed challenges (F-statistic = 7.739, $P = 0.00$). Sharma et al. (2021) and Assoratgoon and Kantabutra (2023) underscored the vital role of leadership support in driving sustainability initiatives and shaping organizational culture.

The absence of clear guidelines and policies did not exhibit significant differences (F-statistic = 1.275, $P = 0.3$), yet Delmas and Toffel (2008) emphasized their importance in guiding employee behavior.

Lack of collaboration and partnerships with external organizations did not significantly differ (F-statistic = 2.729, $P = 0.5$). Despite this, Bansal and Roth (2000) highlighted the benefits of such collaborations in providing resources and fostering innovation.

Resistance to change among staff significantly impeded initiatives (F-statistic = 14.466, $P = 0.00$). Addressing employee concerns, providing training, and fostering a culture of change were emphasized by Aranda-Usón et al. (2019) and Hargreaves et al. (2018) as essential strategies.

Inadequate infrastructure and facilities posed significant challenges (F-statistic = 21.486, $P = 0.00$). Kibert (2016) stressed the importance of investing in energy efficient technologies and sustainable building design to overcome infrastructure-related hurdles.

4. CONCLUSION AND RECOMMENDATION

The environmental sustainability initiatives implemented in public libraries in Ghana reflect an effort towards promoting green practices, reducing ecological footprints, and fostering a culture of sustainability within library operations. The initiatives, ranging from promoting recycling and energy-saving measures to staff training, environmental awareness programs, and sustainable procurement practices, underscore the libraries' commitment to environmental responsibility and sustainable development.

The significant statistical values associated with these initiatives highlight their effectiveness in driving positive environmental outcomes and contributing to broader sustainability goals. Through these initiatives, libraries are not only reducing their environmental impact but also engaging staff and the community in environmentally conscious behaviors. By promoting eco-friendly commuting options, utilizing sustainable materials, and implementing dedicated teams for sustainability oversight, libraries are playing a vital role in advancing sustainable practices and contributing to a more environmentally friendly and sustainable future. Additionally, the research pinpointed challenges faced by libraries, including financial constraints, lack of training, limited support, staff resistance to change, and inadequate infrastructure. While some challenges were not statistically significant, they still hold importance in implementing successful sustainability efforts.

In order to enhance environmental sustainability practices within public libraries in Ghana, it is essential to implement tailored awareness campaigns that address the unique concerns and preferences of diverse library stakeholders. Customizing communication strategies based on gender, age, educational background, and job roles can significantly improve engagement in sustainability initiatives. For example, storytelling sessions on environmental conservation for children and workshops on sustainable practices for adults can cater to different age groups. Continuous training programs for library staff focusing on recycling, energy conservation, and digital resource utilization should also be prioritized, ensuring relevance to their specific roles.

Also, organizing community workshops and events centered on sustainability themes such as tree planting campaigns and waste management workshops can foster a culture of

environmental responsibility. Engaging the public through interactive sessions will promote active participation and a sense of ownership in sustainability efforts.

Policy recommendations include creating inclusive frameworks that consider the diverse backgrounds of library staff and promoting continuous professional development in sustainability. Future research should explore the intersection of gender with cultural factors, conduct long-term studies on staff awareness evolution, and compare sustainability practices across different regions. Rigorous assessments of training programs will also be vital for developing evidence-based practices in Ghanaian libraries.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

As per international standard or university standard, participant's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

The researchers addressed ethical issues related to this study. The respondents were assured of confidentiality of the information they provided. They were also assured of anonymity if the information given was to be quoted in the study or elsewhere. The respondents were given the opportunity to indicate their willingness to participate in the study or not. Official permission was also sought from the public libraries investigated. The respondents were also encouraged to ask questions, seek clarification of questions they do not understand, and provide responses that are as honest as possible.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Afum, E., Agyabeng-Mensah, Y., Sun, Z., Frimpong, B., Kusi, L. Y., & Acquah, I. S. K. (2020). Exploring the link between

green manufacturing, operational competitiveness, firm reputation and sustainable performance dimensions: A mediated approach. *Journal of Manufacturing Technology Management*, 31(7), 1417–1438.

Al Breiki, M., & Nobanee, H. (2019). The role of financial management in promoting sustainable business practices and development. Available at SSRN 3472404. https://papers.ssrn.com/sol3/papers.cfm?aabstract_id=3472404

Amoah, P., & Eweje, G. (2022). Barriers to environmental sustainability practices of multinational mining companies in Ghana: An institutional complexity perspective. *Corporate Governance: The International Journal of Business in Society*, 22(2), 364–384.

Aranda-Usón, A., Portillo-Tarragona, P., Marín-Vinuesa, L. M., & Scarpellini, S. (2019). Financial resources for the circular economy: A perspective from businesses. *Sustainability*, 11(3), 888.

Assoratgoon, W., & Kantabutra, S. (2023). Toward a sustainability organizational culture model. *Journal of Cleaner Production*, 136666.

Audunson, R., Aabø, S., Blomgren, R., Evjen, S., Jochumsen, H., Larsen, H., Rasmussen, C. H., Vårheim, A., Johnston, J., & Koizumi, M. (2019). Public libraries as an infrastructure for a sustainable public sphere: A comprehensive review of research. *Journal of Documentation*, 75(4), 773–790.

Bae, S. Y., Oh, J. T., Park, J. Y., Ha, S. R., Choi, J., Choi, H., & Kim, Y. (2020). Improved Eco-Friendly Photovoltaics Based on Stabilized AgBiS₂ Nanocrystal Inks. *Chemistry of Materials*, 32(23), 10007–10014. <https://doi.org/10.1021/acs.chemmater.0c03126>

Bansal, P., & Roth, K. (2000). WHY COMPANIES GO GREEN: A MODEL OF ECOLOGICAL RESPONSIVENESS. *Academy of Management Journal*, 43(4), 717–736. <https://doi.org/10.2307/1556363>

Baricco, M., Tartaglino, A., Gambino, P., Dansero, E., Cottafava, D., & Cavaglia, G. M. C. (2018). University of turin performance in UI GreenMetric energy and climate change. *E3S Web of Conferences*, 48, 03003–03003. https://iris.unito.it/bitstream/2318/1677099/1/MB_339.pdf

- Baumgartner, R. J. (2019). Sustainable development goals and the forest sector—A complex relationship. *Forests*, 10(2), 152.
- Berrone, P., Rousseau, H. E., Ricart, J. E., Brito, E., & Giuliadori, A. (2023). How can research contribute to the implementation of sustainable development goals? An interpretive review of SDG literature in management. *International Journal of Management Reviews*, 25(2), 318–339. <https://doi.org/10.1111/ijmr.12331>
- Beutelspacher, L., & Meschede, C. (2020). Libraries as promoters of environmental sustainability: Collections, tools and events. *IFLA Journal*, 46(4), 347–358. <https://doi.org/10.1177/0340035220912513>
- Bonsu, N. O., TyreeHageman, J., & Kele, J. (2020). Beyond agenda 2030: Future-oriented mechanisms in localising the sustainable development goals (SDGs). *Sustainability*, 12(23), 9797.
- Bredelbach, C., & Rösner, T. (2022). Framework for Implementing UN SDGs in Corporate Strategy Using BSC: Presentation of a Methodology to Use UN SDGs for Measuring Sustainability in Business Contexts. *The International Journal of Sustainability Policy and Practice*, 18(2), 25.
- Chen, J., & Tsou, H. (2006). Information technology adoption for service innovation and firm performance. *2006 International Conference on Service Systems and Service Management*, 1, 472–477. <https://ieeexplore.ieee.org/abstract/document/4114479/>
- Cheshta, G., & Singh, N. (2023). A systems thinking approach to navigate interlinkages to achieve SDGs in India. *Journal of Sustainability Science and Management*, 18(2), 179–196.
- Dada, K. S. J. (2021). Green Library: Reducing carbon footprints towards Sustainable Development in libraries: A Case Study of Federal College of Education Library, Zaria, Nigeria. *Ciência Da Informação Em Revista*, 8(2), 4–15.
- Dean, B. A., Gibbons, B., & Perkiss, S. (2018). An experiential learning activity for integrating the United Nations Sustainable Development Goals into business education. *Social Business*, 8(4), 387–409.
- Debrah, C., Owusu-Manu, D.-G., Kissi, E., Oduro-Ofori, E., & Edwards, D. J. (2020). Barriers to green cities development in developing countries: Evidence from Ghana. *Smart and Sustainable Built Environment*, 11(3), 438–453.
- Delmas, M. A., & Toffel, M. W. (2008). *Survey questionnaire on environmental management practices: Summary of results by industry and practices*. <https://escholarship.org/uc/item/2m62f3mv>
- Deng, Y., Zhou, T., Zhao, G., Zhu, K., Xu, Z., & Liu, H. (2022). Energy Saving Planner Model via Differential Evolutionary Algorithm for Bionic Palletizing Robot. *Sensors*, 22(19), 7545.
- Denona Bogovic, N., & Grdic, Z. S. (2020). Transitioning to a green economy—Possible effects on the croatian economy. *Sustainability*, 12(22), 9342.
- Dunn, R. F., & El-Halwagi, M. M. (2003). Process integration technology review: Background and applications in the chemical process industry. *Journal of Chemical Technology & Biotechnology*, 78(9), 1011–1021. <https://doi.org/10.1002/jctb.738>
- Fedorowicz-Kruszewska, M. (2020). Environmental education in libraries—theoretical foundations and practical implementation. *Library Management*, 41(4/5), 279–293.
- Fonseca, V. F., França, S., Vasconcelos, R. P., Serafim, A., Company, R., Lopes, B., Bebianno, M. J., & Cabral, H. N. (2011). Short-term variability of multiple biomarker response in fish from estuaries: Influence of environmental dynamics. *Marine Environmental Research*, 72(4), 172–178.
- Ghosh, S. (2020). Business' s Commitment to Sustainable Development Goals: An analysis using the Five Ps framework. *Environmental Management and Sustainable Development*, 54–71.
- Gorman, M. (2004). Whither library education? *New Library World*, 105(9/10), 376–380.
- Griggs, D., Smith, M. S., Rockström, J., Öhman, M. C., Gaffney, O., Glaser, G., Kanie, N., Noble, I., Steffen, W., & Shyamsundar, P. (2014). An integrated framework for sustainable development goals. *Ecology and Society*, 19(4). <https://www.jstor.org/stable/26269703>
- Hargreaves, T., Wilson, C., & Hauxwell-Baldwin, R. (2018). Learning to live in a smart home. *Building Research & Information*, 46(1), 127–139. <https://doi.org/10.1080/09613218.2017.1286882>

- Hensher, M., & McGain, F. (2020). Health Care Sustainability Metrics: Building A Safer, Low-Carbon Health System: Commentary examines how to build a safer, low-carbon health system. *Health Affairs*, 39(12), 2080–2087. <https://doi.org/10.1377/hlthaff.2020.01103>
- Huang, R. (2023). SDG-oriented sustainability assessment for Central and Eastern European countries. *Environmental and Sustainability Indicators*, 19, 100268.
- Ikenwe, J. I., & Udem, O. K. (2022). Innovative digital transformation for dynamic information service sustainability in university libraries in Nigeria. *Ikenwe, IJ, & Udem, OK (2022). Innovative Digital Transformation for Dynamic Information Service Sustainability in University Libraries in Nigeria. Folia Toruniensia*, 22, 67–86.
- Imran, M., Das, K. R., & Naik, M. M. (2019). Co-selection of multi-antibiotic resistance in bacterial pathogens in metal and microplastic contaminated environments: An emerging health threat. *Chemosphere*, 215, 846–857.
- Ismail, F. Z., Yaman, R., & Razali, K. N. (2022). Formulating an Assessment Tool for the Implementation of Green Initiatives in Library. *IOP Conference Series: Earth and Environmental Science*, 1067(1), 012021. <https://iopscience.iop.org/article/10.1088/1755-1315/1067/1/012021/meta>
- Jankowska, M. A., & Marcum, J. W. (2010). Sustainability challenge for academic libraries: Planning for the future. *College & Research Libraries*, 71(2), 160–170.
- Jankowska, M. A., Smith, B. J., & Buehler, M. A. (2014). Engagement of academic libraries and information science schools in creating curriculum for sustainability: An exploratory study. *The Journal of Academic Librarianship*, 40(1), 45–54.
- Jones, L., & Wong, W. (2016). More than just a green building: Developing green strategies at the Chinese University of Hong Kong Library. *Library Management*, 37(6/7), 373–384.
- Kang, Q. (2020). Library directors' concerns and attitudes towards going green and sustainability in China: An unexplored area. *Journal of Librarianship and Information Science*, 52(2), 382–398. <https://doi.org/10.1177/0961000618818874>
- Kardung, M., Cingiz, K., Costenoble, O., Delahaye, R., Heijman, W., Lovrić, M., van Leeuwen, M., M'barek, R., van Meijl, H., & Piotrowski, S. (2021). Development of the circular bioeconomy: Drivers and indicators. *Sustainability*, 13(1), 413.
- Keh, H. T., & Xie, Y. (2009). Corporate reputation and customer behavioral intentions: The roles of trust, identification and commitment. *Industrial Marketing Management*, 38(7), 732–742.
- Khalid, A., & Batool, S. H. (2020). A Qualitative Case Study of Green Environment: Practices, Attitudes and Future Strategies of Pakistani University Librarians. *Electronic Green Journal*, 1(44). <https://escholarship.org/uc/item/9gc3s8h6>
- Kharrazi, A., Qin, H., & Zhang, Y. (2016). Urban big data and sustainable development goals: Challenges and opportunities. *Sustainability*, 8(12), 1293.
- Kibert, C. J. (2016). *Sustainable construction: Green building design and delivery*. John Wiley & Sons. [https://books.google.com/books?hl=en&lr=&id=2xgWCgAAQBAJ&oi=fnd&pg=PR15&dq=Kibert+et+al.++\(2016\)+&ots=G90seRg3ru&sig=ND7YKxkquNwfo_fiwimYBq85AMs](https://books.google.com/books?hl=en&lr=&id=2xgWCgAAQBAJ&oi=fnd&pg=PR15&dq=Kibert+et+al.++(2016)+&ots=G90seRg3ru&sig=ND7YKxkquNwfo_fiwimYBq85AMs)
- Krajnc, D., & Glavič, P. (2005). How to compare companies on relevant dimensions of sustainability. *Ecological Economics*, 55(4), 551–563.
- Krejcie, R. V., & Morgan, D. W. (1970). Determining Sample Size for Research Activities. *Educational and Psychological Measurement*, 30(3), 607–610. <https://doi.org/10.1177/001316447003000308>
- Kurbanoğlu, S., & Boustany, J. (2014). From Green Libraries to Green Information Literacy. In S. Kurbanoğlu, S. Špiranec, E. Grassian, D. Mizrachi, & R. Catts (Eds.), *Information Literacy. Lifelong Learning and Digital Citizenship in the 21st Century* (Vol. 492, pp. 47–58). Springer International Publishing. https://doi.org/10.1007/978-3-319-14136-7_6
- Lendínez-Turón, A., Domínguez-Valerio, C. M., Orgaz-Agüera, F., & Moral-Cuadra, S. (2023). Public administration education towards sustainable development goals: Psychometric analysis of a scale. *International Journal of Sustainability in Higher Education*, 24(6), 1177–1196.
- Liyanage, S. I. H., Netswera, F. G., & Motsumi, A. (2021). Insights from EU policy framework in aligning sustainable finance for sustainable development in Africa and

- Asia. *International Journal of Energy Economics and Policy*, 11(1), 459–470.
- Lu, Y., & Jiang, T. (2019). Bi-population based discrete bat algorithm for the low-carbon job shop scheduling problem. *IEEE Access*, 7, 14513–14522.
- Maseny, T. M., & Ngulube, P. (2019). Digital preservation practices in academic libraries in South Africa in the wake of the digital revolution. *SA Journal of Information Management*, 21(1). <https://doi.org/10.4102/sajim.v21i1.1011>
- Mathiasson, M. H., & Jochumsen, H. (2022). Libraries, sustainability and sustainable development: A review of the research literature. *Journal of Documentation*, 78(6), 1278–1304.
- Mayer-Foulkes, D., Serván-Mori, E., & Nigenda, G. (2021). The sustainable development goals and technological capacity. *Revista Panamericana de Salud Pública*, 45, e81.
- Mazlan, M. A., Izhar, T. A. T., Baharuddin, M. F., & Shoid, M. S. M. (2018). Current Development on Social Media Platform for Green Library Technology Initiative. *International Journal of Learning and Development*, 8(3), 113–125.
- Mohiuddin, M., Al Mamun, A., Syed, F. A., Mehedi Masud, M., & Su, Z. (2018). Environmental knowledge, awareness, and business school students' intentions to purchase green vehicles in emerging countries. *Sustainability*, 10(5), 1534.
- Moktadir, Md. A., & Ren, J. (2023). Leveraging environmental, social, and governance strategies for sustainable tannery solid waste management towards achieving sustainable development goals. *Sustainable Development*, sd.2812. <https://doi.org/10.1002/sd.2812>
- Morelli, J. (2011). Environmental sustainability: A definition for environmental professionals. *Journal of Environmental Sustainability*, 1(1), 2.
- Mwanzu, A., Bosire-Ogechi, E., & Odero, D. (2023). The Emergence of Green Libraries in Kenya: Insights from academic libraries. *The Journal of Academic Librarianship*, 49(5), 102601.
- Najmurokhman, A., Ramadhan, E. F., Saputra, D. I., Ismail, N., & Saehu, A. (2023). Development of Automatic Trash Bin for Sorting Metal and Non-Metallic Wastes Using Proximity Sensors and Notifications via Telegram. *2023 9th International Conference on Wireless and Telematics (ICWT)*, 1–5. <https://ieeexplore.ieee.org/abstract/document/10335243/>
- Nishii, L. H. (2013). The Benefits of Climate for Inclusion for Gender-Diverse Groups. *Academy of Management Journal*, 56(6), 1754–1774. <https://doi.org/10.5465/amj.2009.0823>
- Owens, T. L. (2017). Higher education in the sustainable development goals framework. *European Journal of Education*, 52(4), 414–420. <https://doi.org/10.1111/ejed.12237>
- Ozoadibe, C. J., & Obi, H. E. (2023). Exploring renewable energy facility and green building practices for improved archives preservation in public libraries in Rivers state. *Journal of Environmental Science and Economics*, 2(1), 45–54.
- Patyal, V. S., Sarma, P. R. S., Modgil, S., Nag, T., & Dennehy, D. (2022). Mapping the links between Industry 4.0, circular economy and sustainability: A systematic literature review. *Journal of Enterprise Information Management*, 35(1), 1–35. <https://doi.org/10.1108/JEIM-05-2021-0197>
- Perera, S., Adeniyi, O., Babatunde, S. O., & Ginige, K. (2018). Mapping built environment professionals' educational needs to international policy frameworks for disaster risk reduction—community stakeholder perspective. *International Journal of Disaster Resilience in the Built Environment*, 9(4/5), 368–384.
- Pinzone, M., Guerci, M., Lettieri, E., & Huisingh, D. (2019). Effects of 'green' training on pro-environmental behaviors and job satisfaction: Evidence from the Italian healthcare sector. *Journal of Cleaner Production*, 226, 221–232.
- Rathert, N. (2016). Strategies of legitimation: MNEs and the adoption of CSR in response to host-country institutions. *Journal of International Business Studies*, 47(7), 858–879. <https://doi.org/10.1057/jibs.2016.19>
- Saito, O., Kamiyama, C., Hashimoto, S., Matsui, T., Shoyama, K., Kabaya, K., Uetake, T., Taki, H., Ishikawa, Y., & Matsushita, K. (2019). Co-design of national-scale future scenarios in Japan to predict and assess natural capital and ecosystem services. *Sustainability Science*, 14, 5–21.
- Santos, M. J., & Silva Bastos, C. (2021). The adoption of sustainable development goals by large Portuguese companies. *Social Responsibility Journal*, 17(8), 1079–1099.

- Schmermbeck, H., Thünnesen, J., Voss, N., & Ahlemann, F. (2020). *Green IS does not just save energy—insights from a survey on organizations' uses of sustainable technologies*.
<https://scholarspace.manoa.hawaii.edu/handle/10125/63852>
- Sharma, S., Prakash, G., Kumar, A., Mussada, E. K., Antony, J., & Luthra, S. (2021). Analysing the relationship of adaption of green culture, innovation, green performance for achieving sustainability: Mediating role of employee commitment. *Journal of Cleaner Production*, 303, 127039.
- Silva, A. F., Sánchez-Hernández, M. I., & Carvalho, L. C. (2023). Local Public Administration in the Process of Implementing Sustainable Development Goals. *Sustainability*, 15(21), 15263.
- Surroca Aguilar, J., Tribo Gine, J. A., & Waddock, S. (2010). *Corporate responsibility and financial performance: The role of intangible resources*. <https://e-archivo.uc3m.es/handle/10016/6079>
- Veil, S. R., & Bishop, B. W. (2014). Opportunities and Challenges for Public Libraries to Enhance Community Resilience. *Risk Analysis*, 34(4), 721–734.
<https://doi.org/10.1111/risa.12130>
- Velten, S., Jager, N. W., & Newig, J. (2021). Success of collaboration for sustainable agriculture: A case study meta-analysis. *Environment, Development and Sustainability*, 23(10), 14619–14641.
<https://doi.org/10.1007/s10668-021-01261-y>
- Whang, S.-W., & Kim, S. (2015). Balanced sustainable implementation in the construction industry: The perspective of Korean contractors. *Energy and Buildings*, 96, 76–85.
- Williams, B. F., Charney, M., & Smith, B. (2015). Growing our vision together: Forming a sustainability community within the American Library Association. *Sustainability: Science, Practice and Policy*, 11(2), 57–69.
<https://doi.org/10.1080/15487733.2015.11908147>
- Wu, F., Wang, X., & Liu, T. (2023). Sustainable development goals, natural resources and economic growth: Evidence from China. *Resources Policy*, 83, 103520.
- Zobundžija, V., & Dolaček-Alduk, Z. (2021). The role of higher education libraries in promoting sustainable development—an example of the practice of the library at the Faculty of Civil Engineering and Architecture Osijek. *E-Zbornik: Electronic Collection of Papers of the Faculty of Civil Engineering*, 21.
https://e-zbornik.gf.sum.ba/images/radovi/e-Zbornik_21_05_en.pdf
- Zotoo, I. K., & Liu, G. (2019). Research Data Management (RDM) strategy for academic libraries in Ghana: Setting a national development agenda. *Open Access Library Journal*, 6(4), 1–24.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the publisher and/or the editor(s). This publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/126965>