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EXPLORING RENEWABLE ENERGY FACILITY AND GREEN BUILDING PRACTICES FOR IMPROVED ARCHIVES PRESERVATION IN PUBLIC LIBRARIES IN RIVERS STATE

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Abstract

This study explored renewable energy facility and green building practices for improved archives preservation in public libraries in Rivers state. Two objectives, two research questions and two hypotheses guided this study. Using a descriptive survey design, this study targeted 514 library staff from the Rivers State Library Board (RSLB) and Jubilee Library (JLP) in Port Harcourt. Using Taro Yamane's formula to determine sample size, 399 employees (227 employees of RSLB and 172 employees of JLP) were selected using stratified and random sampling techniques. The data collection tool used was a self-made questionnaire entitled "Renewable Energy and Green Buildings in Public Library Archives"; three experts confirmed its superficial and content validity. The Cronbach alpha reliability estimate for this instrument gives a reliability coefficient of 0.78. the research questions were answered using Mean and Standard Deviation, while z-test was used to conduct the inferential statistics. The findings showed that Rivers state libraries can preserve archives with renewable energy and green building practices, such as solar power, passive ventilation, native landscaping, water-efficient fixtures and regulated humidity. Based on the findings, it can be concluded that incorporating renewable energy into green building practices can have a significant impact on preserving library archives. Additionally, public libraries in Rivers State should partner with the Ministry of Culture and Tourism in order to transition to renewable energy sources (e.g., solar, batteries, wind turbines) to improve archives preservation.

Keywords: Renewable Energy; Green Building; Archives Preservation; Public Libraries

INTRODUCTION

Renewable energy is a type of energy that is derived from natural sources that are constantly replenished, such as solar power, wind power, hydro power, and geothermal heat (Shinn, 2022). These sources of renewable energy are considered as clean energy because they do not emit pollutants into the atmosphere, which helps to reduce contamination in the environment. Renewable energy facilities are becoming increasingly popular as a sustainable energy source, and the proliferation of renewable energy technologies across the globe is resulting in reduced reliance on fossil fuels, improved air quality and the initiation of the transition to a more sustainable future through clean energy (Shinn, 2022). Green building practices have also gained relevance in recent times as researchers draw attention to the effect buildings can have on their surrounding environment. Green buildings are designed with the aim of being more energy and water efficient, as well as utilizing materials that are less harmful to the environment. There is considerable debate surrounding whether or not green building practices can help to regulate temperature within a building. However, natural ventilation and sunlight regulation have been demonstrated to have tangible effects in this regard, and green building practices may serve to reduce the overall energy consumption of a structure – thus further contributing to lower temperatures (United Nations, 2022). Renewable energy facility implementation combined with green building practices could help improve archive preservation in public libraries, since these measures have been observed to effectively address wider environmental impacts. Climate change, deforestation, and pollution are major factors that can have devastating impacts on archives in public libraries.

Climate change can cause alterations to local and global climate patterns, increased frequency and severity of extreme weather events, changes in the distribution and abundance of plant and animal species, as well as modifications to local and global ecosystems. Deforestation can lead to habitat loss, biodiversity decline, and other deleterious effects on archives in public libraries. Pollution too is a major factor that can have devastating impacts. Therefore, implementing renewable energy facilities and green building practices in public libraries can help to mitigate the negative impacts of these factors on archive preservation (United States Energy Information Administration, 2021). Notably, the preservation of rare collections - particularly those related to culture, writings, recordings, events and innovations - is essential for creating a society grounded in ethics, life-long learning and sustainable practice. The importance of archives preservation cannot be overstated. Unfortunately, archivists all over the world - especially in developing nations - have been raising the alarm about the accelerating destruction of archives due to wider environmental impacts. Additionally, the cost of preserving archives from degradation has been cited as a major obstacle in their preservation efforts. Motivated by this challenge, we sought to explore affordable and renewable energy appliances and tools coupled with green building practices that could effectively be harnessed to improve archives preservation. Thus, in aiming at exploring renewable energy facility and green building practices for improved archives preservation in public libraries in Rivers state, specific objectives such as: 1.establishing ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state and. 2. ascertaining how green building practices can improve archives preservation in public libraries in Rivers state will go a long way to provide needed insight to archivists, stakeholders and researchers seeking for contemporary public library practices in archives preservation. Importantly, this study sought to provide relevant answers and test of hypotheses through primary data collection to the foregoing.

LITERATURE REVIEW

The concept of this study is anchored on renewable energy facility and green building practices for improved archives preservation in public libraries in Rivers state as diagrammatically represented in figure 1;

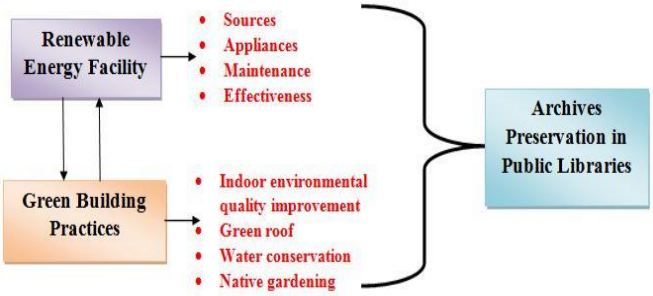

Figure: 1 Renewable Energy Facility and Archives Preservation

It is encouraging to see that libraries and archives are increasingly turning to sustainable energy sources like solar and wind to power their operations. Libraries are taking steps towards making their facilities more energy-efficient, with renovations, construction efforts, and other initiatives aimed at reducing their overall carbon footprint (Shawnda, 2023). By investing in renewable energy, libraries can save on energy costs in the long run as the cost of solar panels and wind turbines continue to decrease over time (McGraw-Hill Construction, 2010). Moreover, the benefits of sustainable energy go beyond just cost savings. By reducing their reliance on non-renewable energy sources, libraries can help to mitigate the of climate change and contribute towards a more sustainable future.
However, it is important to note that building infrastructure for cleaner energy generation can also create carbon emissions (Krajick, 2022). Similarly, United States Environmental Protection Agency (US EPA) (2015) acknowledged that public libraries provide invaluable archives and important resources that can be preserved with the use of renewable energy facility components. However, it is also important to ensure that these institutions are powered by sustainable and renewable energy sources to minimize their environmental impact. Renewable energy sources such as wind, hydroelectric, and solar energy can be utilized to power tools, appliances, and other energy-saving systems in public libraries (US EPA, 2015; Burclaff, n.d.). For instance, libraries can install vertical axis wind turbines on their rooftops to generate renewable power for their facilities. Similarly, small-scale wind turbines can be used to power individual appliances, thus reducing energy consumption (Burclaff, n.d.). Hydropower is also a potential source of renewable energy that can be used to power public libraries. Turbines can be

placed in rivers and bodies of water near the library, converting the pressure of water into energy that can be used to power the library's tools and appliances. Additionally, solar panels can be installed on the rooftops of the library building to provide a steady and renewable energy source. Solar energy can be used to power tools and appliances within the library, as well as lighting and other energy-saving systems. In addition to using renewable energy sources, libraries can also conserve energy by installing energy-efficient appliances such as LED lights, refrigerators, air conditioners, and washing machines. Automated systems such as occupancy sensors and timer switches can also be installed to ensure that energy is used efficiently. By taking advantage of renewable energy sources and energy-efficient tools and appliances, public libraries can improve their overall efficiency and reduce their environmental impact (US EPA, 2015). Moreover, investing in renewable energy sources for libraries has both economic and environmental benefits. By switching to renewable energy providers, libraries can send a message to the industry that there is a high demand for renewable energy services. This can encourage more investment in renewable energy infrastructure and ultimately bring down the cost of renewable energy. Libraries have the power to positively influence the environment by advocating for increased use of renewable energy sources, hosting educational events, partnering with local organizations, and encouraging community members to make their own energy-efficient choices (International Energy Agency (IEA), 2021).

In the same vein, Khalid et al (2021) admitted that public libraries have an important role to play in mitigating the effects of climate change by adopting renewable energy sources and energy-efficient appliances. By doing so, they can not only reduce their carbon footprint but also preserve their valuable archives and resources for future generations. Notably, renewable energy facility does not require as much maintenance as non-renewable energy. This is because they do not need any sort of fuel to run and will last as long as the source of energy is available (Burclaff, n.d.). However, they do require regular maintenance to keep them running in good condition. This will help to make them last longer and allow them to operate to the best of their ability. This type of maintenance can be performed by a renewable energy technician (Wiesner, 2014). This technician will go over the system and fix any problems that are found. They will also install a preventative maintenance schedule to ensure it is still running smoothly. Similarly, Wong et al (2017) acknowledged that for effectiveness, there is a need for conducting the proper maintenance of renewable energy facility that is being used in powering appliances in a public library.

There are several things that should be done by the maintenance team in order to keep the facility working. Among the maintenance tasks are oiling and lubricating, cleaning and wiping and testing the condition of the facility (Rahman, et al., 2022; Rashedi, et al., 2013). Some also include adjustments and calibrations, cleaning the fan and filters and replacing the worn out parts (Chudnovsky, 2017). The maintenance of the facility should be done on regular basis in order to keep the environment safe and clean. This is akin to Agyekum et al (2021 that the maintenance on renewable energy facility is crucial and needs to be done by qualified experts to prevent any damage or accidents due to the wear and tear of the machine. One of the preventive maintenance that needs to be carried out is the regular cleaning of the solar panels with a suitable solution to remove any dust or dirt that is accumulated on the panels. Another preventive maintenance is the regular checking of the batteries and inverter (Aboagye, et al., 2022; Jarčević, et al., 2022; Fioravanti, et al, 2020). If any inverter is getting faulty, it must be replaced immediately to ensure that it does not cause any mishap.

Green Building Practices and Archives Preservation

Increasingly, public libraries are recognizing their responsibility to leverage sustainable building practices in order to protect the environment and conserve resources. This goes in line with Kornfeind (2022) that libraries are becoming increasingly aware of the absolute necessity of incorporating sustainable building practices into their operations in order to protect the environment and maximize the efficient utilization of resources. This shift in mindset is driven by an understanding of the importance of global conservation efforts and the need to reduce waste and greenhouse gas emissions.

Green building practices can include anything from making use of local materials to installing energy-efficient lighting and heating systems, as well as reducing water consumption through water-efficient fixtures. (Aziz & Beg, 2022). With that in mind, libraries can use green building principles to create spaces that are energy efficient and cost effective, while also being healthy and comfortable for their patrons and staff (Binks, et al., 2014). Additionally, they are uniquely positioned to take advantage

of these principles to ensure the preservation of the collections they hold in trust for the public. According to Gengzhe (2016), by adopting green building principles, libraries can establish spaces that are not only salubrious and cozy but also energy-efficient with quality indoor environment, thereby enabling them to cost-effectively maintain their collections and entrust them to the public. To achieve these desired outcomes, public libraries must prioritize four crucial areas: ventilation, lighting, acoustics, and materials selection. To maximize in terms of ventilation, lighting, acoustics and materials selection, libraries should consider employing green building practices.

Afacan (2017) added that by doing this, not only will they be environmentally friendly but also better equipped for preserving their valuable collections. This is akin to Kibert (2016) that effectively incorporating green building practices can lead to indoor environments that are both ecologically sound and conducive to preserving library collections. Martini (2020) noted that the advantages that archives gain from a public library's well-maintained interior environment are immense and cannot be overstated. Such an atmosphere is essential for the preservation of fragile artifacts, while also providing a comfortable and inviting space for patrons to appreciate the collections within. Moreover, with the right balance of humidity and temperature control, documents can be better protected from damage due to environmental factors (Edwards, 2011). In addition, research has highlighted the remarkable contribution of green roofs to the quality of indoor environments in archives (Zeiler, 2022; Dvorak & Rottle, 2021), as well as the need for native garden landscaping (Hanum & Murod, 2014) in order to maintain these standards. Not only do green roofs help to improve air quality, but they also enable archives to benefit from greater insulation and soundproofing (Nurmi, et al., 2013) – both key factors in preserving their contents over time. In addition, green roofs offer numerous other advantages such as stormwater management and biodiversity conservation (Shafique, et al., 2018; Williams, et al., 2014), making them a desirable component of any green building practice aimed at ensuring optimal environmental conditions for archives. Native garden landscaping is a horticultural technique that involves the inclusion of native flora and fauna in a landscape (Hoyle, et al., 2017). It is an effective means of generating aesthetically pleasing outdoor living spaces that are harmoniously integrated with their surrounding environment.

Native plants, which are indigenous to the area, require less maintenance than non-native varieties and help to promote local biodiversity (Alam, et al., 2017). Furthermore, they also reduce water usage and prevent soil erosion, making them ecologically beneficial for the indoor environment of archives. Similarly, Loach and Rowley (2022), Ig-Worlu (2021), as well as Rakhshandehroo and Salahi (2020) observed that landscaping, can have an important role in the preservation of library archive. Not only does it help to mitigate potential environmental hazards that could damage archival materials, but it can also create an aesthetically pleasing and inviting atmosphere to attract visitors and promote interest in the archives. However, it is important to note that all landscape vegetation can ignite under the right conditions, which means that careful selection of plants and trees is crucial to avoid fuel for wildfires (Parkins, et al., 2022).

Ultimately, a high-quality indoor environment in public libraries is invaluable for archives, as it is instrumental in safeguarding important cultural artifacts and making them accessible to the general public

THEORETICAL FRAMEWORK

Living Building Challenge (LBC) Theory

This study is situated on living building challenge theory propounded by Jason F. McLennan in 2006. The living building challenge theory simply emphasize the need for having regenerative buildings that connect occupants to light, air, food, nature, and community in such a way and manner that it will be self-sufficient and remain within the resource limits of its site while creating a positive impact on the human and natural systems that interact with them (McLennan in Sadler, 2021). Hence, as corroborated by Aggarwal (2020), the LBC theory advances the exploration and articulation of relationships between nature, built environments and human physical and psychological activities and wellbeing. It has in its components the need for having buildings that incorporate living plants and efficient use of water in their exterior or interior in the light of increased sustainability. In application to this study, renewable energy facility have shared similarity with the concept of green building practices because both need each other in having a living building. A building where the effects of climate change is limited, thereby providing archivists with an enabling environment to carry out their services effectively. Also, since the essence of the LBC

theory is to ensure sustainability at its best in buildings, having such theory adapted to archives preservation will seamlessly aid archivists in best practices of archives preservation when properly applied (Pradhan, et al., 2019; Vallas & Courard, 2017; Adan & Samson, 2011).

METHODOLOGY

This study employed a descriptive survey design and targeted 514 library staff from the Rivers State Library Board (RSLB) and Jubilee Library Port Harcourt (JLP). Utilizing the Taro Yamane sample size determination formula, a sample size of 399 was selected via a two-stage sampling technique that incorporated stratified and simple sampling. Data collection was facilitated by the 'Renewable Energy and Green Building for Public Library Archives Preservation Questionnaire (REGBPLAPQ)' - an instrument with 10 items in two sections, which was reviewed by three experts for face and content validation and yielded a Cronbach Alpha reliability coefficient of 0.78.

Mean and standard deviation were used to answer research questions while z-test was utilized to test the null hypotheses at 0.05 level of significance. Of 192 copies administered to respondents from RSLB, 84.58% were returned fully completed; for those from and JLP, 93.61% were returned fully completed.

FINDINGS / RESULTS

Results in Table 1 showed the weighted mean values for the response of RSLB and JLP staff on ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state. All the items were agreed by the respondents (xx, > 2.5) except items 4 and 5 (xx, < 2.5).

The items that were agreed on demonstrated ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state. However, the items that were disagreed on demonstrated expected ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state but not being considered. As a result, the mean set cluster value of 2.51 for all of the items implies that the public library archives in Rivers state are making some efforts in the use of renewable energy facility to improve the archives preservation.

Table 1: Mean and Standard Deviation scores on ways in which renewable energy facility can improve archives preservation in public libraries in River's state.

S/N	Using renewable energy facility to improve archives preservation by:	RSLB Staff (n =192)		JLP Staff (n =161)		Mean Set	Remarks
		$\bar{x}$	sd	x_{-}	sd	xx	
1.	powering the archives through solar panel and quality inverter batteries;	2.59	1.61	2.55	1.60	2.57	Agreed
2.	ensuring that regular maintenance is scheduled for the solar panel and inverter batteries;	2.53	1.59	2.56	1.60	2.55	Agreed
3.	replacing existing appliance with LED types;	2.72	1.65	2.61	1.62	2.67	Agreed
4.	installing occupancy sensors to automatically indicate the presence of a person;	2.38	1.54	2.40	1.55	2.39	Disagreed
5	installing timer switches to guarantee that illumination systems are deactivated or dimmed in accordance with a predetermined timetable.	2.36	1.54	2.41	1.55	2.39	Disagreed
	Cluster Mean	2.52	1.59	2.51	1.58	2.51	Agreed

Table 2: Mean and Standard Deviation scores on how green building practices can improve archives preservation in public libraries in Rivers state

S/N	Adapting green building practices to improve archives preservation by:	RSLB Staff (n =192)		JLP Staff (n =161)		Mean Set	Remarks
		x_{-}	sd	x_{-}	sd	xx	
6	improving the quality of indoor environment of archives through proper passive ventilation;	2.94	1.72	2.77	1.66	2.86	Agreed
7	improving the quality of indoor environment of archives through proper native garden landscaping;	2.50	1.58	2.52	1.59	2.51	Agreed
8.	improving the quality of indoor environment of archives through the installation of green roofs;	2.38	1.54	2.33	1.53	2.36	Disagreed
9.	having water-efficient fixtures in place in the archives;	2.80	1.67	2.86	1.69	2.83	Agreed
10	maintaining humidity at a constant level.	2.53	1.59	2.57	1.60	2.55	Agreed
	Cluster Mean	2.63	1.62	2.61	1.62	2.62	Agreed

Results in Table 2 showed the weighted mean values for the response of RSLB and JLP staff on how green building practices can improve archives preservation in public libraries in Rivers state. All the items were agreed by the respondents (xx, > 2.5) except item 8 (xx, < 2.5). The items that were agreed on demonstrated how green building practices can improve archives preservation in public libraries in Rivers state. However, the items that were disagreed on demonstrated expected green building practices that can improve archives preservation in public libraries in Rivers state that are not being considered. As a result, the mean set cluster value of 2.62 for all of the items implies that the public library archives in Rivers state are making some efforts in green building practices to improve archives preservation.

Table 3: z-test analysis on the mean difference between the responses of staff from Rivers state library board and staff from Jubilee library Port Harcourt on ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state.

Status	N	$\bar{x}$	sd	Df	z-cal	z-crit value	Level of significance	Decision
RSLB staff	192	2.52	1.59	351	2.01	1. 96	0.05	Significant difference
JLP staff	161	2.51	1.58					

Table 4: z-test analysis on the mean difference between the responses of staff from Rivers state library board and staff from Jubilee library Port Harcourt on how green building practices can improve archives preservation in public libraries in Rivers state.

Status	N	$\bar{x}$	sd	Df	z-cal	z-crit value	Level of significance	Decision
RSLB staff	192	2.63	1.62	351	0.54	1. 96	0.05	Not Significant
JLP staff	161	2.61	1.62					

Results in Table 3 showed that RSLB staff has mean and standard deviation scores of 2.52 and 1.59 while JLP staff has mean and standard deviation scores of 2.51 and 1.58. With a degree of freedom of 351, the z-calculated value of 2.01 was higher than the critical z-test value of 1.96. Therefore, the null hypothesis was not retained. By implication, there was a significant difference between the mean responses of RSLB and JLP staff on ways in which renewable energy facility can improve archives preservation in public libraries in Rivers state.

Results in Table 4 showed RSLB staff has mean and standard deviation scores of 2.63 and 1.62 while JLP staff has mean and standard deviation scores of 2.61 and 1.62. With a degree of freedom of 351, the z-calculated value of 0.54 was lower than the critical z-test value of 1.96. Therefore, the null hypothesis was retained. By implication, there was no significant difference between the mean responses of RSLB and JLP staff on how green building practices can improve archives preservation in public libraries in Rivers state.

DISCUSSION OF FINDINGS

The findings of this study are discussed under the following subheadings:

Improving Archives Preservation with Renewable Energy Facility in Public Libraries in Rivers State

It was found that renewable energy facility can improve archives preservation in public libraries in Rivers state by replacing existing appliance with LED types. Others are: powering the archives through solar panel and quality inverter batteries while ensuring that regular maintenance is scheduled for the solar panel and inverter batteries; However, others that were disagreed on by the respondents include installing occupancy sensors to automatically indicate the presence of a person and installing timer switches to guarantee that illumination systems are deactivated or dimmed in accordance with a predetermined timetable. This finding supports the finding of Gupta (2020) that adopting emerging innovative and smart technologies that can be integrated into the functioning of library archives are crucial to improving the quality of archives' environment. Similarly, the findings of this study resonate with the findings of the Library of Congress. (n.d.) that it is true that different types of light sources are possible, including daylight, tungsten, fluorescent, and metal halide. Other light sources include LED and halogen. When archives are in direct sunlight, damage can accumulate over time, following the principle of reciprocity. This implies that the total effect of light exposure is directly proportional to the intensity and length of exposure. For example, light can negatively affect archives in the form of fabric, dye, and art. This is because light can destroy the chemical bonds in the pigments, which results in them losing their vibrancy over time. Additionally, light exposure can lead to yellowing and a darkening of archives in the form of paper, plastics, and photographs, as well as a weakening of archives in the form of leather and wood. Ultimately, light exposure can lead to colour changes and bleaching in archives in the form of textiles and paintings, which in turn affects their appearance and value.. For this reason, all light sources used for display should ideally produce only visible light, with ultraviolet (UV) or infrared (IR) radiation eliminated (The Library of Congress, n.d.).

Improving Archives Preservation with Green Building Practices in Public Libraries in Rivers State

It was found that in improving archives preservation with green building practices in public libraries in Rivers state, there is a need to ensure that the green building practices provides for an improved quality of indoor environment through proper passive ventilation, and proper native garden landscaping. Others are: having water-efficient fixtures in place in the archives and maintaining humidity at a constant level. However, the respondents disagreed on improving the quality of indoor environment of archives through the installation of green roofs. This finding supports the finding of Gupta (2020) that the planet is experiencing the unparalleled effects of climate change- the term 'pollution', 'e-waste', and 'depletion of natural resources' have become prevalent in our vocabulary. Thus, it is not out of place to say that today's libraries should harness their capacity to assume responsibility and address the environmental sustainability issue by creating green libraries. As such, incorporating green practices into the day-to-day operations of library archives has become paramount to the number of studies dedicated to improving the preservation of archives. Similarly, the findings of this study also correspond with Abbey (2012)'s research that documented a 40-year increase in the number of publications and research in library science that focused on green practices in cultural, academic, and public heritage establishments in saner climes. These endeavours are part of a larger issue that is known as environmental sustainability. This term is also used to describe the ability to satisfy all of the fiscal, environmental, communal, and cultural needs of the

present without negatively affecting the similar needs of forthcoming generations. Abbey (2012) continued their research by noting that several books, articles, and professional organizations currently advocate for sustainable library services and facilities, including green construction and business practices that are environmentally sensitive. However, studies in archival science have primarily focused on the architecture of facilities and environmental regulation, rather than a comprehensive approach that promotes simple, attainable, green initiatives that archivists can readily participate in (Abbey, 2012)

CONCLUSION AND RECOMMENDATION

Based on the research's findings, it can be concluded that the incorporation of renewable energy facilities into green building practices has the potential to have a significant impact on the preservation of archives in public libraries. However, the practices considered to be green in buildings for improving archives preservation do not significantly differ between the respondents' strata. Also, occupancy sensors, which indicate the presence of a person automatically, may not be necessary in improving the preservation of archives, as the archives are typically devoid of traffic and does not require constant supervision. In this instance, it seems that the respondents believed that other strategies, such as passive ventilation and water-efficient fixtures, would have a greater impact and be more practical for improving the environment of archives. As a result, they would have a positive effect in improving archives preservation of public libraries in Rivers state. The following recommendations were made based on the findings of the study:

1. The management of public libraries in Rivers state should liaise with the Ministry of Culture and Tourism in the state in order to work towards the replacement of fossil fuel powered sources with renewable energy sources, such as solar panels, batteries or vertical axis wind turbines so as to improve archives preservation in the public libraries.
2. The management of public libraries in Rivers state should liaise with the Ministry of Environment in the state so as to promote innovative green libraries such as the best of native garden landscaping (in terms of design and vegetation) that can mitigate the potential environmental impact of climate change on archives.
3. The management of public libraries in Rivers state should participate in professional development programmes on the use and maintenance of renewable energy appliances as well as innovative green building practices in improving archives preservation.

LIMITATION AND STUDY FORWARD

Building on the recent study, two additional variables that could be used to improve archives preservation in public libraries have been proposed. Much work still needs to be done by scholars in order to find the best methods for deploying renewable energy sources and facilities in archives under different geographical regions.

CONFLICT OF INTEREST AND ETHICAL STANDARDS

The ethical guidelines and practices adopted by the authors of this manuscript have been verified and all authors have provided written consent to be published. The journal's submission requirements and standards have also been fully complied with by all authors.

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