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Benefits of a Smart Building Design in Public Library Facilities, Lagos State, Nigeria

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Abstract: *The study refers to the benefits in the adoption of a smart building design in public library facilities, Lagos State, Nigeria. Public libraries in Lagos serve as vital resources for education, information, and community activities. However, challenges such as outdated infrastructure, limited financial resources and varying levels of technological literacy among the community need to be addressed to ensure successful integration. The study examined the practicality, benefits, challenges, costs associated with integrating smart technologies and infrastructure such as smart lighting, heating, ventilation, air conditioning systems, occupancy sensors, energy management systems etc. The research methodology present in this study was sampling technique and sampling procedure, sampling frame, instrument for data collection, and data analysis techniques. The study discussed public library facilities, the criteria for categorization smart buildings, basic smart devices needed in public library buildings, problems and solutions identified with public library buildings in Lagos. The findings of this study indicated that introducing smart building design for a public library facility offers several notable benefits which include significant energy savings, improved indoor environmental quality, enhanced user experience through personalized services, and efficient space utilization. Moreover, smart building features enable real-time monitoring and data analytics for informed decision-making and maintenance. However, the challenges that needs to be addressed during the assessment process include high upfront costs, interoperability and data security concerns, potential disruptions during the transition phase, and the need of training staff to utilize the new technologies effectively. Overall, with careful planning, stakeholder involvement, and appropriate fundings, the library can embrace smart technologies to enhance its operational efficiency, user experience, sustainability, and contribute positively to the surrounding community.*

Keywords: Benefits, adoption, smart building design, public library, facility.

1. INTRODUCTION

Public libraries have traditionally served as a vital community space, providing access to knowledge, resources, and cultural enrichment. However, many public libraries face challenges related to outdated infrastructure and technological use in an increasingly digital age (El-Hadi, 2012). Public libraries often face competition for funds with other essential public services which limits financial resources and hinder the acquisition of new materials, technology upgrades, and staff development (Smith, 2019). The challenges of a public library can also involve adapting to the evolving needs and preferences of library patrons, including increased reliance on digital resources (Lancaster, 2003). Kaid (2017) stated that public libraries often face difficulty in keeping up with the latest technologies and their integration into library services causing digital divide such as unequal access to technology and digital literacy skills among patrons. Hence, the integration of smart building designs into public libraries present an opportunity to transform these spaces into technologically advanced, efficient and user centric environments. Wang et al. (2020) explored the application of IoT and AI in designing smart libraries. They discussed how these technologies can improve services and user experiences by implementing a smart city evaluation system based on a cloud computing platform. The integration of IoT and AI enables libraries to offer personalized services, automate routine tasks, and provide real-time information to users, enhancing overall efficiency and satisfaction. Lee and Kim (2018) explored the technological aspects and benefits of smart libraries in improving information services. Zhang and Liu (2021) emphasized the importance of Smart building energy management system. By addressing these challenges and leveraging the opportunities presented by smart building technologies, public libraries can become more dynamic, responsive, and sustainable spaces that meet the needs of their communities.

In Lagos state, where technological innovation is rapidly advancing, there exists an opportunity to modernize public libraries. Lagos State Government (2021) provided insights into the development priorities and strategies for infrastructure enhancement in Lagos State. However, challenges such as outdated infrastructure, limited financial resources and varying levels of technological literacy

among the community, need to be addressed to ensure successful integration. Ebiwolate (2010) discussed the challenges faced by libraries in Nigeria and the need for technological advancement. Understanding the global trends in smart libraries and the specific context of Lagos State is essential to conduct a comprehensive feasibility study.

Public libraries in Lagos State face significant challenges in infrastructure, technological integration, and operational efficiency. Anira (2011) highlighted the role of libraries in communities and their significance for sustainable development. However, despite their critical role as community hubs for education and information dissemination, the lack of modernization and technological advancement hinders their ability to effectively meet the evolving needs of users. Lagos State Library Board (2021) provided insights into the existing state of Libraries within the State, highlighting challenges and opportunities for improvement. The question thus arises whether implementing smart building designs in these public libraries is feasible, considering the complex interplay of technological, infrastructural, financial, and social factors within the local context of Lagos State. Aina (2004) highlighted the challenges and strategies in public library services in Nigeria.

Hence, the challenges of outdated infrastructure and limited technological integration within public libraries in Lagos State hinder their ability to meet the evolving needs of users in an increasingly digital era. This statement identifies the core challenges faced by public libraries in Lagos State, emphasizing the need for technological advancement through smart building designs.

The aim and objectives of the research benefits in the adoption of a smart building design in a public library facility are to: assess the existing infrastructure and technological capabilities of public libraries in Lagos State and investigate the limitations of the integration of smart building technologies.

2. METHODOLOGY

The benefits of adoption of a smart building design in a public library facility has gained significant attention due to the potential benefits it can offer in terms of energy efficiency, sustainability, and improved user experience.

2.1 Materials

2.1.1 Energy management

Several studies have highlighted the importance of integrating energy management systems and technologies in achieving energy efficiency in public libraries. R. Fitton (2020) proposed the integration of occupancy sensors and smart lighting systems to automatically adjust lighting levels based on user presence, that leads to significant energy savings. Figure 1 shows a smart building framework.

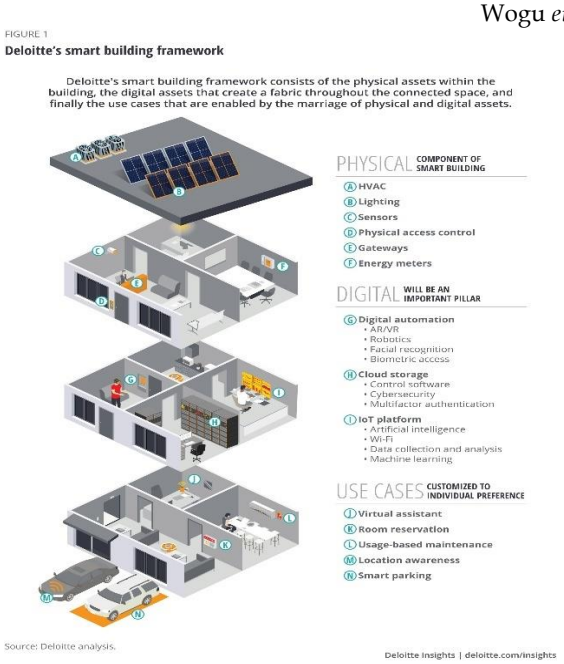

Figure 1: A smart building design (Deloitte analysis)

2.1.2 User comfort and experience

Smart building design can greatly enhance the user experience in public libraries through personalized services and improved comfort levels. Kumar et al. (2021) explored the integration of ambient intelligence and smart technologies to provide personalized library spaces tailored to individual preferences. They found that such systems can increase user satisfaction and engagement. Kari and Seppo (2022) highlighted the significance of smart HVAC systems in maintaining optimal thermal conditions and indoor air quality, thus improving user comfort and well-being. Figure 2 shows internet of things.

Figure 2: Internet of things (www.graphicriver.net)

2.1.3 Operational efficiency

Smart building offers several opportunities to enhance the operational efficiency of public libraries. Chen (2022) suggested the use of data analytics and real-time monitoring systems to optimize facility management, maintenance, reducing downtime and improving operational efficiency. Li (2022) investigated the integration of smart space utilization systems in libraries, which lead to improved space management and more efficient use of available

resources. Also, despite the benefits of implementing smart building design in public libraries it can pose several challenges. Zoeteman et al. (2014) highlighted interoperability issues and the need for standardized protocols to ensure seamless integration of various smart technologies. A smart building is displayed in Figure 3.

Figure 3: A smart building (green.org)

2.2 Research Methods

The study is located in Lagos State. The case study used are Herbert Macauley public library and Ikeja secretariat public library. The study adopted a judgement (or purposive) and stratified sampling methods to be effective given the diverse stakeholders involved. The respondents encompass a diverse range of stakeholders directly or indirectly involved in the library system and its enhancements. They include:

i. Library management staff (library directors/ managers, librarians and technicians).
ii. Technology experts (IT professionals, smart building specialists).
iii. Education and research experts (educators, researchers).

2.3 Data Analysis

A total of 200 copies of the questionnaire were administered to users, library management staff and para-professionals' staff in the two selected public libraries (Herbert Macauley public library and Ikeja secretariat public library), Technology experts, educational and research experts. One hundred and twenty-one (60.5%) copies of the questionnaires were returned. The questionnaires were analysed into various sections. Table 1 shows the distribution of questionnaires to respondent in the two libraries used as study.

Table 1: Distribution of questionnaires to both libraries

S/N	Respondence	No of respondence	%
1	Library users	120	60.0
2	Librarian	35	17.5
3	Library officer	25	12.5
4	Library technician	5	2.5
5	Educational and research experts	15	7.5
	Total	200	100%

Tables 2 and 3 shows the number of questionnaires retrieved and gender analysis by respondence in the two libraries used as study respectively. Table 4 shows the age ranges of respondence.

Table 2: Retriever of questionnaires from both libraries

S/N	Respondence	No of respondence	%
1	Library users	105	86.8
2	Librarian	6	5.0
3	Library officer	10	8.3
4	Library technician	0	0
5	Educational and research experts	0	0
	Total	121	100%

Table 3: Gender analysis of both public libraries

S/N	Respondence	No of respondence	%
1	Male	50	41.3
2	Female	71	58.7
	Total	121	100%

Table 4: Distribution of respondents by age

S/N	Respondence	No of respondence	%
1	15-25 years	57	47.1
2	26-35 years	34	28.1
3	36-45 years	19	15.7
4	46 years and above	11	9.1
	Total	121	100%

3. RESULTS AND DISCUSSION

When designing a public library facility using smart design principles, several key aspects should be considered to create a modern, efficient, and user-friendly environment.

3.1 The use of smart design for public libraries

Table 5 presents data on the demography information of the respondents categorized by gender and roles played in the understudied public library. The total number of respondents is 121. Among these, the majority are library users, accounting for 105 individuals or 86.8% of the total. Librarians make up 6 participants, representing 5.0%, while library officers account for 10 participants, which is 8.3% of the total. Notably, there are no library technicians among the participants, as indicated by 0 individuals in that category.

Table 5: Demographic information of respondents

Items	Scale	Frequency	Percentage
Gender	Male	50	41.3
	Female	71	58.7
	Total	121	100%
Role played in the library	Library user	105	86.8
	Librarian	6	5.0
	Library officer	10	8.3
	Library technician	0	0

Items	Scale	Frequency	Percentage
	Total	121	100.0

Source: Authors fieldwork

3.2 Impact of smart building technologies on energy consumption of Epe public library

The impact of smart building technologies on energy consumption of Epe public library were analysed with simple percentage frequency counts as shown in Table 6.

Table 6 indicates a strong consensus among respondents regarding the benefits of implementing smart building technologies in the public library.

Table 6: Impact of smart building technologies on energy consumption of Epe public library

Items	Scale	Frequency	Percentage
Smart building technologies can significantly reduce energy consumption in the public library	Strongly Disagree	1	8
	Disagree	5	4.1
	Neutral	6	5.0
	Agree	92	76.0
	Strongly Agree	17	14.0
	Total	121	100.0
Implementing smart building systems will lower the operational costs of the public library	Strongly Disagree	1	8
	Disagree	5	4.1
	Neutral	6	5.0
	Agree	92	76.0
	Strongly Agree	17	14.0
	Total	121	100.0
Energy-efficient smart technologies are essential for sustainable library management	Strongly Disagree	0	0
	Disagree	1	8
	Neutral	9	7.4
	Agree	80	66.1
	Strongly Agree	31	25.6
	Total	121	100.0
The library has high potential for energy savings. through smart building technologies	Strongly Disagree	0	0
	Disagree	1	8
	Neutral	8	6.6
	Agree	83	68.6
	Strongly Agree	29	24.0
	Total	121	100.0
The cost savings from reduced energy consumption justify the investment in smart building systems	Strongly Disagree	0	0
	Disagree	3	2.5
	Neutral	10	8.3
	Agree	74	61.2
	Strongly Agree	34	28.1
	Total	121	100.0
Smart building technologies will lead to long-term financial benefits for the library	Strongly Disagree	0	0
	Disagree	2	1.7
	Neutral	10	8.3
	Agree	82	67.8
	Strongly Agree	27	22.3
	Total	121	100.0

Source: Authors fieldwork

A significant majority (76%) agree and 14% strongly agree that these technologies can significantly reduce energy consumption, while only 0.8% strongly disagree and 4.1% disagree. Similarly, 76% agree and 14% strongly agree that implementing smart building systems will lower operational costs, with minimal disagreement (0.8% strongly disagree, 4.1% disagree). The necessity of energy-efficient smart technologies for sustainable library

management is supported by 66.1% agreeing and 25.6% strongly agreeing, with only 0.8% disagreeing. The potential for energy savings through smart technologies is acknowledged by 68.6% agreeing and 24% strongly agreeing, with minimal disagreement (0.8%).

Additionally, 61.2% agree and 28.1% strongly agree that the cost savings from reduced energy consumption justify the investment in these systems, while only 2.5% disagree. Finally, the expectation of long-term financial benefits from smart building technologies is supported by 67.8% agreeing and 22.3% strongly agreeing, with only 1.7% disagreeing. Overall, the data reflects a strong belief in the positive impact of smart building technologies on the library's energy efficiency and financial sustainability.

3.3 Impact of smart building technologies on the operational costs

The impact of smart building technologies on the operational costs of Epe public library were analysed with simple percentage frequency counts as displayed in Table 7.

Table 7: Impact of smart building technologies on the operational costs

Items	Scale	Frequency	Percentage
Smart building technologies will reduce maintenance costs for the public library	Strongly Disagree	0	0
	Disagree	19	15.7
	Neutral	8	6.6
	Agree	84	69.4
	Strongly Agree	10	8.3
	Total	121	100.0
The implementation of smart systems will streamline library operations	Strongly Disagree	1	8
	Disagree	11	9.1
	Neutral	3	2.5
	Agree	90	74.4
	Strongly Agree	16	13.2
	Total	121	100.0
Smart technologies will improve the cost-efficiency of library services	Strongly Disagree	2	1.7
	Disagree	10	8.3
	Neutral	4	3.3
	Agree	65	53.7
	Strongly Agree	40	33.1
	Total	121	100.0
The integration of smart systems will result in lower utility bills for the library	Strongly Disagree	3	2.5
	Disagree	8	6.6
	Neutral	7	5.8
	Agree	74	61.2
	Strongly Agree	29	24.0
	Total	121	100.0
There will be significant reduction in operational disruptions with smart building systems	Strongly Disagree	1	8
	Disagree	5	4.1
	Neutral	11	9.1
	Agree	74	61.2
	Strongly Agree	30	24.8
	Total	121	100.0
The library can allocate more resources to mother areas by saving on operational costs through smart technologies	Strongly Disagree	2	1.7
	Disagree	3	2.5
	Neutral	10	8.3
	Agree	86	71.1
	Strongly Agree	20	16.5
	Total	121	100.0

Source: Authors fieldwork

Table 7 indicates a strong consensus among respondents regarding the benefits of smart building technologies for the public library. The majority agree that these technologies will reduce maintenance costs, with 69.4% agreeing and 8.3% strongly agreeing. Similarly, 74.4% agree and 13.2% strongly agree that implementing smart systems will streamline library operations. Additionally, 53.7% agree and 33.1% strongly agree that smart technologies will improve cost- efficiency. For utility bills, 61.2% agree and 24.0% strongly agree that integration will result in lower costs. A significant portion also believes in reduced operational disruptions, with 61.2% agreeing and 24.8% strongly agreeing. Finally, 71.1% agree and 16.5% strongly agree that savings from operational costs can allow the library to allocate more resources to other areas. Overall, the data suggest strong positive perceptions of smart building technologies' impact on various aspects of library operations.

3.4 Advantages of integrating smart security systems in library building

The advantages of integrating smart security systems in library building of Epe public library were analysed with simple percentage frequency counts as shown in Table 8.

Table 8: Advantages of integrating smart security systems in library building

Items	Scale	Frequency	Percentage
Smart security systems will enhance the overall safety of the public library	Strongly Disagree	1	8
	Disagree	14	11.6
	Neutral	5	4.1
	Agree	88	72.7
	Strongly Agree	13	10.7
	Total	121	100.0
The integration of smart security system will prevent theft and vandalism	Strongly Disagree	2	1.7
	Disagree	7	5.8
	Neutral	13	10.7
	Agree	84	69.4
	Strongly Agree	15	12.4
	Total	121	100.0
Smart security technologies will ensure better surveillance and monitoring of library premises	Strongly Disagree	8	6.6
	Disagree	11	9.1
	Neutral	60	49.6
	Agree	37	30.6
	Strongly Agree	5	4.1
	Total	121	100.0
The library staff and visitors will feel safer with the implementation of smart security systems	Strongly Disagree	2	1.7
	Disagree	5	4.1
	Neutral	5	4.1
	Agree	83	68.6
	Strongly Agree	26	21.5
	Total	121	100.0
Smart security systems will provide real-time alerts and responses to security threats	Strongly Disagree	0	0
	Disagree	7	5.8
	Neutral	1	8
	Agree	84	69.4
	Strongly Agree	23	19.0
	Total	121	100.0

Source: Author fieldwork

Table 8 reflects survey responses regarding the impact of smart security systems in the public library, covering five key aspects. A significant majority of respondents (72.7%) agree that these systems will enhance the overall safety of the public library, with an additional 10.7% strongly agreeing with this statement. This indicates a high level of confidence in the potential safety benefits of smart security systems among the respondents. Similarly, when it comes to the prevention of theft and vandalism, 69.4% agree and 12.4% strongly agree that the integration of smart security systems will be effective. This suggests that most respondents believe these systems will contribute significantly to reducing criminal activities in the library.

However, opinions on whether smart security technologies will ensure better surveillance and monitoring of library premises are more varied. A large portion of respondents (49.6%) are neutral on this aspect, which may indicate uncertainty or a lack of awareness about how these technologies function. Meanwhile, 30.6% agree and 4.1% strongly agree that smart security will improve surveillance and monitoring, showing that there is some recognition of the benefits but also a substantial portion of ambivalence or doubt.

Regarding the sense of safety for library staff and visitors, 68.6% agree and 21.5% strongly agree that the implementation of smart security systems will make them feel safer. This strong positive response highlights the perceived personal security benefits that these systems can offer. Lastly, a combined 88.4% of respondents (69.4% agree and 19.0% strongly agree) believe that smart security systems will provide real-time alerts and responses to security threats, demonstrating a high level of trust in the systems' ability to enhance immediate threat management.

Overall, the majority view smart security systems positively, with strong agreement on their potential to enhance safety, prevent theft and vandalism, and provide real-time alerts. The only notable area of neutrality is in the opinions on better surveillance and monitoring, which suggests that further information or evidence may be needed to convince the neutral respondents of the efficacy of these technologies in that specific aspect.

3.5 Challenges to implementing smart systems in public library buildings

The challenges to implementing smart systems in Epe public library were analysed with simple percentage frequency counts as shown in Table 9.

Table 9: Challenges to implementing smart systems in Epe public library

Items	Scale	Frequency	Percentage
The cost of implementing smart building technologies is a major barrier	Strongly Disagree	4	3.3
	Disagree	17	14.0
	Neutral	11	9.1
	Agree	82	67.8
	Strongly Agree	7	5.8
	Total	121	100.0
There is a lack of technical expertise to maintain smart systems in the library	Strongly Disagree	7	5.8
	Disagree	16	13.2
	Neutral	6	5.0
	Agree	79	65.3
	Strongly Agree	13	10.7
	Total	121	100.0
The existing infrastructure of the library is incompatible with smart technologies	Strongly Disagree	1	8
	Disagree	18	14.9
	Neutral	7	5.8
	Agree	62	51.2
	Strongly Agree	33	27.3
	Total	121	100.0
Resistance to change among library staff is a challenge to implementing smart systems	Strongly Disagree	4	3.3
	Disagree	12	9.9
	Neutral	8	6.6
	Agree	72	59.5
	Strongly Agree	25	20.7
	Total	121	100.0
There is insufficient funding available for the installation of smart building technologies	Strongly Disagree	5	4.1
	Disagree	11	9.1
	Neutral	9	7.4
	Agree	74	61.2
	Strongly Agree	22	18.2
	Total	121	100.0
Regulatory and compliance issues pose a barrier to the adoption of smart systems in the library	Strongly Disagree	7	5.8
	Disagree	10	8.3

Items	Scale	Frequency	Percentage
	Neutral	11	9.1
	Agree	82	67.8
	Strongly Agree	11	9.1
	Total	121	100.0

Source: Author fieldwork

Table 9 presents comprehensive survey responses regarding the barriers to implementing smart building technologies in Epe public library. A significant majority of respondents, totalling 73.6%, perceive the cost of implementing smart building technologies as a major barrier, with 67.8% agreeing and 5.8% strongly agreeing. Only a small portion disagrees, with 14% disagreeing and 3.3% strongly disagreeing. The lack of technical expertise to maintain smart systems is another notable issue, with a combined 76% of respondents expressing concern, comprising 65.3% who agree and 10.7% who strongly agree. A minority of 13.2% disagree and 5.8% strongly disagree, while 5% remain neutral.

In terms of infrastructure compatibility, 78.5% of respondents believe the existing infrastructure is incompatible with smart technologies, with 51.2% agreeing and 27.3% strongly agreeing. This is contrasted by 14.9% who disagree and 0.8% who strongly disagree, and 5.8% who are neutral. Resistance to change among library staff is highlighted as a significant challenge, with 59.5% agreeing and 20.7% strongly agreeing, making up a total of 80.2%. This concern is only countered by 9.9% who disagree and 3.3% who strongly disagree, with 6.6% neutral.

Insufficient funding is seen as a problem by a majority of 79.4% of respondents, with 61.2% agreeing and 18.2% strongly agreeing. Meanwhile, 9.1% disagree and 4.1% strongly disagree, and 7.4% remain neutral.

Finally, regulatory and compliance issues are considered a barrier by 76.9% of respondents, with 67.8% agreeing and 9.1% strongly agreeing. A smaller fraction disagrees, with 8.3% disagreeing and 5.8% strongly disagreeing, while 9.1% are neutral. This data collectively underscores the prevalent challenges faced in integrating smart technologies in the library, with cost, technical expertise, infrastructure compatibility, staff resistance, funding, and regulatory issues being significant concerns for the majority of respondents.

3.6 Library staff readiness to accept smart technologies

The library staff readiness to accept smart technologies were analysed with simple percentage frequency counts as shown in Table 10.

Table 10: Library staff readiness to accept smart technologies

	Scale	Frequency	Percentage
Library staff are open to learning about new smart technologies	Strongly Disagree	1	8
	Disagree	19	15.7
	Neutral	12	9.9
	Agree	84	69.4
	Strongly Agree	5	4.1
	Total	121	100.0
The staff are willing to undergo training for the implementation of smart systems	Strongly Disagree	3	2.5
	Disagree	13	10.7
	Neutral	10	8.3
	Agree	79	65.3
	Strongly Agree	16	13.2
	Total	121	100.0
There is a positive attitude among staff towards the adoption of smart technologies	Strongly Disagree	2	1.7
	Disagree	11	9.1
	Neutral	13	10.7
	Agree	59	48.8
	Strongly Agree	36	29.8
	Total	121	100.0
Library staff believe that smart technologies will improve their work efficiency	Strongly Disagree	3	2.5
	Disagree	7	5.8
	Neutral	12	9.9
	Agree	71	58.7

	Scale	Frequency	Percentage
	Strongly Agree	28	23.1
	Total	121	100.0
The staff are ready to support the integration of smart building systems in the library	Strongly Disagree	2	1.7
	Disagree	8	6.6
	Neutral	12	9.9
	Agree	79	65.3
	Strongly Agree	20	16.5
	Total	121	100.0
There is a strong willingness among staff to embrace technological advancements in the library	Strongly Disagree	2	1.7
	Disagree	10	8.3
	Neutral	11	9.1
	Agree	73	60.3
	Strongly Agree	25	20.7
	Total	121	100.0

Source: Author fieldwork

Table 10 reveal a predominantly positive attitude among library staff towards the adoption of smart technologies. Most respondents agree or strongly agree that staff are open to learning about new smart technologies, with 69.4% agreeing and 4.1% strongly agreeing, while only a small minority of 15.7% disagree and 0.8% strongly disagree. This trend continues with the staff's willingness to undergo training for smart systems implementation, as evidenced by 65.3% agreeing and 13.2% strongly agreeing, compared to just 10.7% disagreeing and 2.5% strongly disagreeing.

Similarly, the majority have a positive attitude towards adopting smart technologies, with 48.8% agreeing and 29.8% strongly agreeing, while only 9.1% disagree and 1.7% strongly disagree. Furthermore, a large portion of staff believe smart technologies will enhance work efficiency, with 58.7% agreeing and 23.1% strongly agreeing, contrasted with 5.8% disagreeing and 2.5% strongly disagreeing. Support for integrating smart building systems is high, with 65.3% agreeing and 16.5% strongly agreeing, compared to just 6.6% disagreeing and 1.7% strongly disagreeing. Finally, there is a strong willingness among staff to embrace technological advancements, with 60.3% agreeing and 20.7% strongly agreeing, while only 8.3% disagree and 1.7% strongly disagree. In contrast, the percentages of staff who strongly disagree or disagree with these statements are consistently low across all items, indicating overall positive reception towards smart technologies in the library. The neutral responses vary but remain a smaller fraction compared to those expressing agreement, suggesting that while some staff may be uncertain, the majority are clearly in favour of adopting and supporting smart technologies in their work environment.

3.7 State of existing infrastructure in the public library

The state of existing infrastructure in the public library were analysed with simple percentage frequency counts as shown in Table 11.

Table 11: State of existing infrastructure in the public library

Items	Scale	Frequency	Percentage
The existing infrastructure of the library is capable of supporting smart technologies	Strongly Disagree	7	5.8
	Disagree	34	28.1
	Neutral	4	3.3
	Agree	73	60.3
	Strongly Agree	3	2.5
	Total	121	100.0
The library has adequate technological resources for the implementation of smart systems	Strongly Disagree	11	9.1
	Disagree	25	20.7
	Neutral	10	8.3
	Agree	62	51.2
	Strongly Agree	13	10.7
	Total	121	100.0
There is a need for upgrading the library's infrastructure to integrate smart technologies	Strongly Disagree	6	5.0
	Disagree	16	13.2
	Neutral	12	9.9

Items	Scale	Frequency	Percentage
	Agree	52	43.0
	Strongly Agree	35	28.9
	Total	121	100.0
The current state of technological capabilities in the library is sufficient for smart system integration	Strongly Disagree	5	4.1
	Disagree	24	19.8
	Neutral	11	9.1
	Agree	59	48.8
	Strongly Agree	22	18.2
	Total	121	100.0
The library's infrastructure is outdated and requires modernization for smart technologies	Strongly Disagree	7	5.8
	Disagree	13	10.7
	Neutral	12	9.9
	Agree	73	60.3
	Strongly Agree	16	13.2
	Total	121	100.0
The existing technological capabilities of the library can easily accommodate smart building systems	Strongly Disagree	6	5.0
	Disagree	19	15.7
	Neutral	12	9.9
	Agree	67	55.4
	Strongly Agree	17	14.0
	Total	121	100.0

Source: Author fieldwork

Table 11 indicates varied perceptions regarding the library's infrastructure and its capacity to support smart technologies. A majority (60.3%) of respondents agree that the existing infrastructure is capable of supporting smart technologies, although a significant portion (28.1%) disagree, indicating some division in opinion. In terms of the library having adequate technological resources for the implementation of smart systems, over half (51.2%) agree, but there is also notable disagreement (20.7%), suggesting that while many see the resources as sufficient, a considerable number of respondents do not share this view.

When asked about the need for upgrading the library's infrastructure to integrate smart technologies, a substantial number of respondents (43.0% agree and 28.9% strongly agree) believe that upgrades are necessary, reflecting a strong sentiment towards improvement and modernization. Similarly, 48.8% agree and 18.2% strongly agree that the current state of technological capabilities in the library is sufficient for smart system integration, yet 19.8% disagree, showing that while there is a belief in the adequacy of current capabilities, a significant minority remains sceptical.

Regarding the modernization of the library's infrastructure, 60.3% agree and 13.2% strongly agree that it is outdated and requires updating to support smart technologies, whereas 10.7% disagree, pointing to a consensus on the need for modernization. Lastly, the belief that the existing technological capabilities of the library can easily accommodate smart building systems is supported by 55.4% agreement and 14.0% strong agreement, though 15.7% disagree, indicating a general confidence in current capabilities, yet acknowledging room for improvement.

These findings highlight a dual perspective: there is confidence in the library's current infrastructure and technological capabilities to some extent, but there is also a clear recognition of the need for updates and improvements to fully integrate and support smart technologies.

4. CONCLUSION

After thorough analysis and evaluation of various factors related to the assessment of smart building design, it is evident that there are significant benefits to be gained from embracing this innovative approach for a public library building management and operations. The study has highlighted several key findings. respondents overwhelmingly support the implementation of smart building technologies in the Epe public library, believing these systems will positively impact energy efficiency, financial sustainability, and overall operations. A majority see the benefits in reducing energy consumption, operational costs, and enhancing safety with smart security systems. However, there are significant concerns regarding the barriers to implementation, especially related to costs, technical expertise, infrastructure compatibility, and staff resistance to change.

While the library staff generally show readiness to adopt and learn about smart technologies, they acknowledge the need for upgrading the library's infrastructure. The findings indicate that while many are optimistic about the library's current infrastructure supporting smart systems, there is a consensus on the necessity of modernization and improvements to fully harness the benefits of smart technologies.

REFERENCES

[1] Aina, L. O. (2004). Public library services in Nigeria: Challenges and strategies. Library Management, 25(4/5), 265-274.

[2] Anira, I. O. (2011). Academic library and challenges of service delivery in Nigerian universities in the digital era. African Journal of Library, Information and Knowledge Management, 1(1), 1-10.

[3] Council, U. G. B. (1998). US green building council. Washington, DC, USA: US Green Building Council.

[4] Chen, C.-H.V., and Chen, Y.-C. (2022). "Influence of intellectual capital and integration on operational performance: big data analytical capability perspectives." *Chinese Management Studies*, 16(3), 551-570. doi: 10.1108/CMS-02-2021-0037.

[5] Ebiwolate, L. O. (2010). Public libraries in contemporary Nigeria: Challenges and the way forward. Library Philosophy and Practice (e-journal).

[6] El-Hadi, M. A. (2012). Challenges facing public libraries in developing countries: A case study of Egypt. Library Management, 33(4/5), 281-290. https://doi.org/10.1108/01435121211228888.

[7] Fitton, R. (2020). Energy pathology: measuring a dwellings energy performance using smart meter and IoT data. *Journal of Building Survey*, Appraisal and Valuation, 9(2), 181-190

[8] Hassanain, M.A., Sanni-Anibire, M.O. and Mahmoud, A.S., 2024. An assessment of users' satisfaction with a smart building on university campus through post-occupancy evaluation. *Journal of Engineering, Design and Technology*, *22*(4), pp.1119-1135.

[9] Javed, A., Malhi, T., Kinnunen, T., and Främling, K. (2020). Scalable IoT Platform for Heterogeneous Devices in Smart Environments. *IEEE Access*, 8, 211973-211985. doi: 10.1109/Access.2020.3039368.

[10] Kaid, L. (2017). Libraries in the digital age: Challenges and opportunities. Journal of Librarianship and Information Science, 49(1), 3-15. https://doi.org/10.1177/0340833116686923

[11] Kari, A., and Seppo, S. (2022). An overview of machine learning applications for smart buildings. *Sustainable Cities and Society*, 76, 103445. doi: 10.1016/j.scs.2021.103445.

[12] Kim, D., Yoon, Y., Lee, J., Mago, P.J., Lee, K. and Cho, H., 2022. Design and implementation of smart buildings: A review of current research trend. *Energies*, *15*(12), p.4278.

[13] Kumar, A., Sharma, S., Goyal, N., Singh, A., Cheng, X. and Singh, P., 2021. Secure and energy-efficient smart building architecture with emerging technology IoT. *Computer Communications*, *176*, pp.207-217.

[14] Lagos State Government (2021). Development priorities and strategies for infrastructure enhancement in Lagos State. https://lagosstate.gov.ng/

[15] Lagos State Library Board (2021) The existing state of Libraries within the State, highlighting challenges and opportunities for improvement. https://libraryboard.lagosstate.gov.ng

[16] Lancaster, F. W. (2003). The future of libraries: An agenda for change. Chicago: American Library Association (ALA).

[17] Lee, J. H., and Kim, S. H. (2018). Smart building technology for sustainable development: A review. Renewable and Sustainable Energy Reviews, 81, 1218-1238.

[18] Li, B. (2022). "Effective energy utilization through economic development for sustainable management in smart cities." *Energy Reports*, 8, 4975-4987. doi: 10.1016/j.egyr.2022.02.303.

[19] Li, C.Z., Zhang, L., Liang, X., Xiao, B., Tam, V.W., Lai, X. and Chen, Z., 2022. Advances in the research of building energy saving. *Energy and Buildings*, *254*, p.111556.

[20] Smith, P. (2019). The role of public libraries in contemporary society. Library Trends, 67(3), 251-272. https://doi.org/10.1080/00242583.2019.1578432.

[21] Wang, C., Li, S., Cheng, T. and Li, B., 2020. A construction of smart city evaluation system based on cloud computing platform. *Evolutionary Intelligence*, *13*(1), pp.119-129.

[22] Wang, H., Li, Y., Lin, W. and Wei, W., 2023. How does digital technology promote carbon emission reduction? Empirical evidence based on e-commerce pilot city policy in China. *Journal of Environmental Management*, *325*, p.116524.

[23] Zhan, H., Hwang, B.G., Zhu, H. and Ang, S.H.P., 2023. Towards a sustainable built environment industry in Singapore: Drivers, barriers, and strategies in the adoption of smart facilities management. *Journal of Cleaner Production*, *425*, p.138726.

[24] Zhang, Y., and Liu, J. (2021). Smart building energy management system: A review. Energy and Buildings, 235, 110661.

[25] Zoeteman, A., Dollevoet, R., and Li, Z. (2014). "Dutch research results on wheel/rail interface management: 2001–2013 and beyond." *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, 228(6), 642-651. doi: 10.1177/0954409714524379.