

Li-fi: An emerging technology revolutionising networking in libraries

S.A. Olarongbe¹, A. S. Sulyman², K. A. Eiriemiokhale³, Y. O. Ahmed⁴, & R. Ademola⁵

¹The Polytechnic Librarian
Kwara State Polytechnic
Ilorin, Nigeria.

Olarongbe.sa@unilorin.edu.ng

²Department of Library and Information Science
Institute of Information Communication Technology
Kwara State Polytechnic, Ilorin, Nigeria.

³Department of Library and Information Science,
Faculty of Information and Communication Technology,
Kwara State University, Malete, Nigeria.

⁴Department of Library and Information Science
Federal Polytechnic, Offa, Kwara State, Nigeria.

⁵Department of Computer Science
Institute of Information Communication Technology
Kwara State Polytechnic
Ilorin, Nigeria.

Abstract

The emergence of technologies has greatly exposed libraries to connecting their facilities and resources for seamless sharing and transmissions. Consequently, networking is one of the technological tools aiding the operations and services of libraries. This paper addresses the need for deploying Li-fi for revolutionising networking in the library. This paper adopts typology design to provide a more precise and nuanced understanding of Li-fi, pinpointing and justifying key dimensions of it and its deployment in libraries. Findings revealed that Li-fi is potentially suitable for varied library services including makerspaces, the metaverse, online gaming, digital reading, OPAC, virtual reality (VR), augmented reality (AR), video streaming, remote control systems, and smart libraries. Findings further showed that the major pros of Li-fi are that it increases the network security, speed, availability and minimises external interference in the data flow, while its cons include confined range and compatibility. This paper concludes that the development of Li-fi presents libraries with enormous opportunity to provide state-of-the-art services enhanced by cutting-edge technologies while minimising security risks and misuse of library data.

Keywords: Emerging technology, Li-fi, Libraries, Networking.

Introduction

Libraries have been seen as social institutions saddled with the responsibilities of collecting, processing, organizing, storing, preserving, conserving, locating, retrieving, disseminating, and utilising information resources to meet the recreational, research, and reference needs of the users. Libraries play the role of guardians or gateways to knowledge through the support of librarians who help users in accessing and optimising the values of information (Olarongbe, Eiriemiokhale & Sulyman, 2024). Technology from Sage (2023) described libraries as laboratories of ideas, partners, and pioneers of unrestricted access to information, central to a community to champion intellectual social engagement and contribute to the development of society. Libraries are gateways to knowledge where members of societies have equal rights and opportunities to pursue both their intellectual well-being and development to deepen their freedom, dignity, and economic security.

Being that libraries are integral parts of every thriving society, they are not spared from continuous evolution. This evolution greatly relies on leveraging technologies by libraries. An and Oliver (2021); Niu et al. (2022) asserted that technology such as networking has completely revolutionized the library and information landscape, opening new opportunities for information creation, processing and handling by connecting diverse library resources and facilities. Consequently, it has been observed that networking in libraries has been changing in response to the sophistication of the available telecommunication technologies. This means that libraries themselves have been turned into hubs where emerging technologies are encouraged and provided to strengthen the digital skills of users. The emerging technologies are machines, tools or devices that have the potential to change the current state of affairs in every sphere of human life (Cukurova, Luckin & Baines, 2017; Küfeoğlu, 2022). These technologies have spiralled into networking, with the commonest one is the 5G network.

Dinodia (2024) claimed that the advancement of networking has been characterised by constant innovation aimed at boosting speed, effectiveness, and reach. One of the networking technologies that is reshaping the library and information landscapes is Light Fidelity (Li-fi) (Ouyang, Zheng & Jiao, 2022). Li-fi, uses the power of light to transmit data. Through this process, Li-fi promises speeds that are 100 times faster than the existing networking such as Wi-fi and Mi-fi. Li-fi offers the potential to change the way we connect to the Internet in libraries (Shetty, Smitha & Rai, 2023).

Li-fi is a mobile wireless communications technology that uses light rather than radio frequencies to transmit data. Li-fi is fully networked, and mobile (LiFi Technology, 2024). It heavily relies on light sources to empower signal strength, reduce bit error rate (BER), and strengthen a network's bandwidth (Krishnan, 2024). In this 21st Century where the demand for data continues to grow exponentially, Li-fi presents a viable solution to alleviate the congestion experienced in RF bands, promising a future where both technologies coexist to meet global communication needs (Krishnan, 2024). The invaluable benefits of Li-fi in enhancing library networking underscored why this paper is advocating for the adoption of Li-fi for networking in libraries.

Justifications for the Paper

Libraries are social spaces established for efficient and timely provision and dissemination of information to the users. The emergence of technologies has greatly exposed libraries to connecting their facilities and resources for seamless sharing and transmission. Consequently, networking is one of the technological tools aiding the operations and services of libraries. Revolutionizing library networking has attracted significant attention, due to the importance of networking in 21st-century libraries.

Networking in libraries has been evolutionary. The evolution started from the use of nodes to radio frequency for data transmission. However, studies in recent times have revealed the limitations of using radio frequency for data transmission. Dinodia (2024) bemoaned that radio frequency-based systems' signal reflection and dispersion resulted in low bandwidth and slow data transmission. The currently used networking systems in the library are prone to data abuses and high energy consumption. Realizing this caused a need to research alternative networking systems which is the Li-fi. One of the reliable strengths of Li-fi is its reduction of network latency. Dinodia (2024) posited that latency is one of the factors to be considered in networking. Li-fi offers this because the light waves it uses for data transmission are more effective at carrying data secretly than radio waves. Its direct line-of-sight connectivity ensures that data is sent without the usual radio waves (Krishnan, 2024).

Noting the enormous potential opportunities of Li-fi to libraries in contemporary society and the likelihood of leveraging it to enhance and advance library operations and services makes this paper address the need for deploying Li-fi for revolutionizing networking in the library.

Purpose of the Study

The main purpose of this study is to address the need for deploying Li-fi to revolutionising networking in the library. To achieve the stated purpose, this paper briefly explains the concept of Li-fi; the synergies between Li-fi and some notable and cutting-edge library services it can be deployed for are reviewed. More so, the pros and cons of Li-fi were discussed to clarify these writers' positions on Li-fi's adoption for library services.

Methodology

This paper adopts typology to itemize and analyze the available literature on Li-fi and how it can be deployed in libraries. Jaakkola (2020) posited that a typology paper provides a more precise and nuanced understanding of a phenomenon or concept, pinpointing and justifying key dimensions that distinguish the variants. The typology approach helps this paper explain the emerging Li-fi networking and cutting-edge library services by logically and causally combining them into a coherent and explanatory set of types. Consequently, this paper explains the pros and cons of Li-fi on library services.

Concept of Li-fi Technology

Li-fi is a revolutionary wireless communication system that transmits data using visible light rather than conventional radio frequency (RF) transmissions. Li-fi is a subclass of optical wireless

communication (OWC) systems that uses visible light as a means of transmitting data. It also uses light-emitting diodes (LEDs) to transmit data at incredibly fast rates. The quick on-and-off flashing of these LEDs essentially encodes data in binary form, which a photo detector-equipped receiver may then decipher (Dinodia, 2024).

Li-fi functions as a Visible Light Communications system; at its core, data is transferred from LED light bulbs. These bulbs carry pulses of light that produce information similar to Morse code. The game-changers in Li-fi are the compatible devices that can synthesize this information rapidly (LiFi Technology, 2024). Li-fi offers the possibility of quicker, more secure, and very efficient data transfer, and is set to completely transform the way we interact (Dinodia, 2024).

Li-fi and Suitable Library Services

Libraries now need to constantly reinvent their operations and create new services in the twenty-first century. The development of various library operations has been greatly aided by technological advancement, which has become a transformative force (Valencia-Arias et al., 2024). Izuagbe, et al. (2019) offered evidence in favor of this assertion, arguing that libraries today function as a nexus of developing knowledge resources and information technologies, opening doors into the digital era. Libraries may now make use of new opportunities brought about by technology, such as having unrestricted access to information resources and services and engaging diverse users flexibly and adaptively.

Examining how each form of technology is influencing the library and information ecosystems is crucial given the startling rate at which technology is developing. To do this, emphasis should be placed on their unique qualities, possible applications, benefits, and related issues (An & Oliver, 2021). Li-fi's data will be most effectively utilized in libraries for services that require low latency and real-time data interchange, as it simplifies the process of connecting to the Internet like turning on a lamp (Jandoc, 2024). Makerspaces, the metaverse, online gaming, digital reading, OPAC, virtual reality (VR), augmented reality (AR), video streaming, remote control systems, and smart libraries are some of the services offered by this provider.

Makerspaces are described as high- and low-tech shared learning spaces where users can use digital and fabrication tools to design, build, and invent (Melo, Hirsh, & March, 2023). According to Quigley, Caswell, and Burroughs (2024), makerspace use by libraries has increased recently, positioning them as pioneers in technological innovation. Makerspaces often concentrate on digital fabrication through the use of 3D printers and laser cutters along with other computerized software-driven equipment. One of the most popular locations for a makerspace to exist in today's culture is the library.

According to Cruz, Oliveira, and Pinheiro (2023), the metaverse is a digital realm in which people can engage in daily life and economic activities. It is a three-dimensional virtual world modeled after the real world, but without physical boundaries, allowing people to interact through avatars and partake in social, economic, and cultural activities. The metaverse is in charge of collecting all conceivable dreams and constructing a world that they can live in as well as for us.

Metaverse is a global community that fosters collaboration and integration in all setups, including university libraries (Kontogianni & Anthopoulos, 2024), the metaverse is a combination of elements like online games, social networking, augmented reality, and virtual reality that allow digital engagement (Ramesh et al., 2022). Subaveerapandiyan, Alam, Butdisuwan, and Kataria (2024) noted that the metaverse can be used to create virtual meeting spaces, collaborative research environments, or immersive cultural experiences within the library context.

Digital reading is another library function that Li-fi can be used for, especially in this day and age when libraries must actively support literacy in the community. Digital reading, according to Peras, Klemenčič-Mirazchiyski, Japelj-Pavešić, and Mekiš-Recek (2023), is the sole use of text and other multimedia resources inside an electronic digital context. It mostly entails reading text documents that are digitally shown on screens, such as DOCs or PDFs. Reading digitally requires a unique process where digital environment navigation and text comprehension come together.

The ability of Li-fi to support smart libraries is ultimately what will determine how widely adopted it is in libraries. According to Igwe and Sulyman (2022), smart libraries are those that have been configured with state-of-the-art technologies so that users can access, handle, and collect information without the intervention of librarians. For library services, smart libraries made use of cutting-edge technical techniques such as artificial intelligence (AI), big data, the Internet of things, blockchain, cloud computing, 3D printing, and radio frequency identification (RFID). With the use of Li-fi, smart library services are expected to be improved and upgraded.

Pros of Li-fi on Library Services

Li-fi promises to revolutionise Internet connectivity in libraries by increasing network security, speed, availability and external interference in the data flow (LiFi Technology, 2024; Ouyang, Zheng & Jiao, 2022). Li-fi's speed allows more data to be carried out faster through light sources than with radio waves used by Wi-fi. Also, Li-fi is more energy-efficient as it harnesses the power of LED light bulbs. Similarly, Li-fi enhances data security by reducing the risk of data being intercepted by outside threats. More so, the use of light sources makes Li-fi a reliable means of connecting to the Internet since lights are everywhere (LiFi Technology, 2024).

Dinodia (2024) argued that Li-fi's main benefit is its capacity to carry data at speeds significantly faster than those of traditional Wi-Fi networks—in lab settings, it may occasionally reach speeds of up to 100 Gbps. Li-fi reduced latency in networking, giving consumers a more responsive and seamless experience and connectivity of library gadgets. Li-fi has emerged as a promising alternative for high-speed data transmission. Unlike Wi-fi, which relies on radio waves, Li-fi uses light-emitting diodes (LEDs) to transmit data at extremely high speeds, offering advantages such as higher bandwidth, enhanced security, and reduced interference (Krishnan, 2024).

With Li-fi, data is transferred at an accelerated rate compared to Wi-fi, resulting in higher speeds. The data rate is considered to be the main difference between today's mobile technologies. As we are equipped to increase the data percentage, remote gadgets will want to accomplish more capacities. In this era of communication technology, Li-fi is another and proficient method of

remote communication. Li-fi utilizes LED to communicate information. The data transmission of information is done remotely (Shetty, Smitha & Rai, 2023).

Cons of Li-fi on Library Services

Despite the multitude of opportunities Li-fi promises to offer Internet connectivity in libraries, researchers have identified some challenges peculiar to it. Some of the challenges include limited range and compatibility. (LiFi Technology, 2024). With Li-fi, the Internet connection is confined to closed spaces since this technology relies on light sources. Therefore, large libraries might have a harder time utilizing this technology. Concerning limited compatibility, Li-fi's falling into the realm of a newer technology. This means that fewer devices are equipped to decode its data.

Another problem with Li-fi is it doesn't solve slow Internet speeds from ISPs. The connotation of this is that if libraries are on ISP's slowest plan or are experiencing throttled speeds, Li-fi won't solve these issues. The major limitation of the Li-fi is its reliance on light bulbs. Krishnan (2024) aptly captures the influence of this on Li-fi by asserting that unlike radio frequency signals which can penetrate walls and work over longer distances, visible light requires a direct line of sight to ensure optimal performance. As a result, any deviation in the alignment between the transmitter and receiver can significantly impact the quality of the signal and the data transmission rate.

Conclusion

The development of Li-fi presents libraries with an enormous opportunity to provide state-of-the-art services enhanced by cutting-edge technologies while minimizing security risks and misuse of library data. This paper has clearly explained how, in the twenty-first century, as libraries compete with other information infrastructure and institutions for relevance, Li-fi has emerged as a strong substitute for libraries, providing robust Internet services that libraries can rely on to improve the quality of their operations and expedite their services.

Recommendations

Based on findings from the literature consulted, this paper recommends that:

1. Libraries should always consider the network strength and speed of the Internet Service Provider (ISP) they want to adopt for Li-fi. This will help in overcoming the problem of slow Internet speeds from ISPs, which Li-fi cannot independently solved.
2. Internet Service Providers (ISPs) should be tailoring their forthcoming means of connecting to the Internet to be Li-fi enabled. This will make them manufacture networking devices that are compatible with Li-fi.

Implications of the Study

This paper holds the potential to change the networking processes in libraries, particularly in the 21st Century where libraries are striving to incorporate emerging technologies into their operations and services to be transformed into digital hubs. The adoption of Li-fi in libraries will position libraries for the 21st Century library services such as makerspaces, metaverse, digital reading and storytelling, Internet-of-things (IoT), video streaming, remote control systems and smart libraries.

Some library administrators and managers may be exercising restraints in the adoption of Li-fi because of factors associated with restricted network access, the cost of purchasing the devices needed to install Li-fi, fear of its obsolescence, and inadequate staff skills to harness Li-fi's values to position libraries among the institutions embracing innovations to foster creativity and positive ideas in societies.

References

- An, T., & Oliver, M. (2021). What in the world is educational technology? Rethinking the field from the perspective of the philosophy of technology. *Learning, Media and Technology*, 46(1), 6–19. <https://doi.org/10.1080/17439884.2020.1810066>
- Cruz, M., Oliveira, A. & Pinheiro, A. (2023). Meeting ourselves or other sides of us? — meta-analysis of the metaverse. *Informatics*, 10, 47. <https://doi.org/10.3390/informatics10020047>
- Cukurova, M., Luckin, R., & Baines, E. (2017). The significance of context for the emergence and implementation of research evidence: the case of collaborative problem-solving. *Oxford Review of Education*, 1-16
- Dinodia, P. (2024). Enhancing wireless communication with Li-fi technology: Development and implementation for high-speed, visible light communication systems. *Darpan International Research Analysis*, 12(3), 352-362. DOI: <http://doi.org/10.36676/dira.v12.i3.94>
- Igwe, K.N., & Sulyman, S.A. (2022). Smart libraries: Changing the paradigms of library services. *Business Information Review*, 39 (4), 147-152.
- Izuagbe, R., Ibrahim, N.A., Ogiemien, L.O., Olawoyin, O.R., Nwokeoma, N.M., Ilo, P.I., & Osayande, O. (2019). Effect of perceived ease of use on librarians' e-skills: Basis for library technology acceptance intention. *Library & Information Science Research*, 41 (3), 100969. <https://doi.org/10.1016/j.lisr.2019.100969>.
- Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, 10:18–26. <https://doi.org/10.1007/s13162-020-00161-0>
- Jandoc, T. (2024). What is Li-fi? Get the details on what might be the next big thing for the Internet. <https://www.cnet.com/home/internet/what-is-Li-fi/>
- Kontogianni, E., & Anthopoulos, L. (2024). Towards a standardized metaverse definition: Empirical evidence from the ITU metaverse focus group. *IEEE Engineering Management Review*. DOI:10.1109/EMR.2024.3416331.
- Krishnan, S. (2024). Analyzing the effects of inclination on Li-fi technology. *The American Journal of Interdisciplinary Innovations and Research*, 6(09), 7–12.
- Küfeoğlu, S. (2022). Emerging technologies, sustainable development goals Series. Cambridge, UK: Springer. https://doi.org/10.1007/978-3-031-07127-0_1

- LiFi Technology (2024). About LiFi technology. <https://www.purelifi.com/about-lifi/>
- Melo, M., Hirsh, K. & March, L. (2023). Makerspaces in libraries at U.S. Public Colleges and Universities: A Census. *Portal: Libraries and the Academy*, 23(1), 35–43, <https://doi.org/10.1353/pla.2023.0007>, p.35.
- Niu, S.J., Luo, J., Niemi, H., Li, X. & Lu, Y. (2022). Teachers’ and students’ views of using an AI-aided educational platform for supporting teaching and learning at Chinese schools. *Education Sciences*, 12(12), 858-. <https://doi.org/10.3390/educsci12120858>
- Olarongbe, S.A., Eiriemiokhale, K.A. & Sulyman, S.A. (2024). Deepening the relevance of libraries for the development of societies. Olatokun, W.M., Dike, V.W., Moronkola, O.A., Egunjobi, A.O., Akande, S.O., Aramide, K.A. & Adetimirin, A.E. (2024). A festchrift in honour of Professor David Folorunso Elaturoti. Ibadan: Department of Library and Information Science, University of Ibadan. 281-290.
- Ouyang, F., Zheng, L. & Jiao, P. (2022). Artificial intelligence in online higher education: A systematic review of empirical research from 2011 to 2020. *Education and Information Technologies*, 27(6), 7893–7925. <https://doi.org/10.1007/s10639-022-10925-9>
- Peras, I., Klemenčič-Mirazchiyski, E., Japelj-Pavešič, B. & Mekiš-Recek, Ž. (2023). Digital versus paper reading: A systematic literature review on contemporary gaps according to gender, socioeconomic status, and rurality. *Eur. J. Investig. Health Psychol. Educ*, 13, 1986–2005. <https://doi.org/10.3390/ejihpe13100142>.
- Quigley, B.D., Caswell, T.R. & Burroughs, J.N. (2024). 2024 Top Trends in Academic Libraries: A Review of the Trends and Issues. *College & Research Libraries News*, 85(6), 231-264. <https://escholarship.org/uc/item/86s5k498>
- Ramesh, U.V., Harini, A., Gowri, C.S.D., Durga, K.V., Druvitha, P. & Kumar, U. (2022). Metaverse: Future of the Internet. *Int. J. Res. Publ. Rev.*, 3, 93–97.
- Shetty, S., Smitha, A.B. & Rai, R. (2023). Li-fi Technology and its applications. Modeling and optimization of optical communication networks. <https://doi.org/10.1002/9781119839569.ch20>
- Subaveerapandiyana, A., Alam, A.F., Butdisuwan, S. & Kataria, S. (2024). Exploring emerging technologies: librarians’ awareness, challenges and ethical perspectives in Thai library contexts, with a focus on the metaverse. *Digital Library Perspectives*, DOI 10.1108/DLP-12-2023-0111.
- Technology from Sage. (2023). Librarian futures part III. https://www.technologyfromsage.com/wp-content/upload/2023/04/TFS_Librarian_Futures_Part2_Whitepaper_FINAL.pdf

Valencia-Arias, A., Patiño-Toro, O., Neyra-Alemán, K., Altuna-Tocto, G., Ureta-Medrano, J. Azabache-Gutiérrez, P. (2024). Factors affecting the use of mobile learning among higher education students in developing countries in a post-pandemic context. *IEEE Revista Iberoamericana de Tecnologías del Aprendizaje*, doi: 10.1109/RITA.2024.3460591.