

Smart Lighting Systems for Library Cubicles and Book Racks in Academic Libraries: A Review

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ABSTRACT

The article explores the idea of installing smart lighting in libraries for book racks and cubicles. The aim is to increase user satisfaction, encourage sustainability, and optimize energy efficiency in library settings. Furthermore, by providing suitable lighting for various activities, a smart lighting system can improve user experience. While book racks can have adjustable lighting levels to create a welcoming environment for browsing, cubicles with brighter lighting can be used for reading, learning, or working. Libraries can reduce energy expenses, reduce their impact on the environment, and make their spaces appealing and attractive for users by integrating smart lighting systems. This combination of sustainability and technology satisfies the changing requirements of modern libraries and improves the user experience. The smart lighting system integrates sensors, data analytics, and automation to provide an intelligent and responsive lighting solution. Cubicles and book racks are equipped with motion sensors and ambient light sensors to detect occupancy and environmental lighting conditions. The data collected from these sensors are processed in real-time to adjust the lighting levels, ensuring optimal brightness and energy efficiency. This paper discusses the concerns of smart lighting systems for cubicles and book racks in libraries and reviews ways that libraries can adapt to smart lighting library readers, and optimize energy efficiency in library settings.

KEYWORDS: Index Terms: Smart Libraries, Smart lighting, Cubicles, Book Racks.

1. INTRODUCTION

Smart lighting systems have revolutionized the way we illuminate spaces, offering enhanced efficiency, adaptability, and customization. In settings like cubicles and library book racks, where focused illumination is crucial, the integration of smart lighting technologies not only enhance visibility but also promote energy efficiency and a conducive environment for work and study.

Cubicles and library book racks demand lighting solutions that balance functionality with comfort. Traditional lighting often falls short of meeting these specific requirements, leading to inefficiencies and limitations. However,

the advent of smart lighting systems has addressed these challenges by providing tailored lighting experiences that cater to individual needs while optimizing energy consumption.

By leveraging intelligent sensors, connectivity, and user-friendly controls, smart lighting in cubicles and library book racks offers precise illumination control. It ensures adequate brightness for tasks, minimizes glare, and creates an environment conducive to concentration and productivity. Moreover, these systems contribute to sustainability efforts by optimizing energy usage through features like automated dimming, scheduling, and motion detection.

The advantages and uses of smart lighting systems in cubicles and library book racks are examined in this study, with an emphasis on how these systems can improve user experience, encourage energy saving, and offer flexible spaces that can be adjusted to meet individual needs. To improve functionality, comfort, and sustainability, it is our goal is to show the benefits and potential of deploying smart lighting solutions in various settings through an in-depth analysis.

a) **KEY FEATURES**

1. **Occupancy Sensing:** To identify the presence of users, motion sensors are positioned strategically in book racks and cubicles. The lighting system automatically dims or turns off when sections are left empty for a predetermined amount of time, which helps save energy.
2. **Ambient Light Adjustment:** The natural light levels in the library are analyzed by ambient light sensors. To minimize energy consumption and provide a comfortable and well-balanced environment, the smart lighting system constantly modifies artificial lighting to match natural light.
3. **User Preferences:** A user-friendly the interface lets customers personalize the lighting in their allocated areas by allowing them to choose the color temperature and brightness of the illumination.
4. **Task-Based Lighting:** Diverse library activities necessitate different illumination levels. To improve the user experience, the lighting is adjusted by the system based on the type of activity, such as reading or group work.
5. **Energy Efficiency:** Smart lighting system adds significantly to energy savings by controlling lighting based on occupancy and ambient conditions, which is in line with eco-friendly and sustainable practices.
6. **Centralized Control and Monitoring:** Librarians can monitor energy usage and system performance and make necessary adjustments according to a centrally controlled panel that they may access. The system runs optimally because of this centralized control, which also improves maintenance efficiency.

The concepts of sustainability, user comfort, and operational efficiency are all in line with the installation of smart lighting systems in libraries for book racks and cubicles. Not only can the integration of innovative technologies enhance the entire experience for library users, but it also promotes the the larger objective of building intelligent, sustainable facilities.

2. REVIEW OF LITERATURE

The author of the study, Effect and Importance of Lighting Systems in School Libraries authored by **Leila Hashempour (1), 2018**, discusses the illumination sources and types that will be addressed first in this study, which is based on the literature that is currently available. And provides recommendations for the library lighting system

will be included in this respect, by its fundamental principles. Also speaks about proper illumination by the parts of school libraries. Further, the author highlights that General lighting, or ambient lighting, completely illuminates a space. This type of illumination makes it safe and easy for people to walk through the spaces. Ceiling-mounted fixtures, chandeliers, table lamps, track lights, wall lighting, spotlights, and hanging fixtures are examples of indoor and outdoor lighting that can be used to do this.

The Author, **Chitra Batumalai; Xin Rou Kong; Malathy Batumalay,(2), (2019)**, speak about the Traditional lighting systems used in libraries at universities and colleges, and these systems require switches to regulate the illumination. This will result in needless electrical waste. Therefore, this study proposes a system that uses Internet of Things (IoT) technology to automatically manage the illumination in the library, promoting efficient energy usage. The system makes use of an Arduino board equipped with a motion sensor to track human movement and adjust the lighting in specific library sections. With the help of this system, the organization can increase energy efficiency and better manage the lighting in the library. By implementing this approach, a business can benefit from increased convenience and a more environmentally responsible workplace. The author **Chitra Batumalai; Xin Rou Kong; Malathy Batumalay,(2), (2019)**, further discusses on the methodology, two methodologies were used in this study on the system's implementation. The initial approach used was a questionnaire to collect input in the form of comments from different users in a specific area of interest. This survey is intended to gather input from a variety of sources to analyze the findings. To gather data and information, a second interview was done between the system analyst and users. It is beneficial to collect data and information from the interviewee to enhance the suggested system based on user needs. Further, the author concludes that based on the system's scope and utilization, this system is appropriate for use in libraries. This technology is effective in raising power efficiency and is robust and trustworthy. It achieves the objective of conserving energy and facilitates the effective utilization of energy resources. Because the system is automated, cost-effective, and power-efficient, artificial intelligence can be further enhanced. This system is an attempt to increase the rate of technological advancement.

The author, **Djoko Sigit Sayogo;, Sri Budi Cantika Yulia; Wiyono (3) 2022**, the study speaks about the support of public library functions and pinpoints the major factors that influence their ability to offer intelligent services and initiatives that encourage citizen participation in open government. Utilizing information from a public library survey. In the analysis section the author, **Djoko Sigit Sayogo;, Sri Budi Cantika Yulia; Wiyono (3) 2022**, discussed the idea that the public has different expectations of public libraries when it comes to online interactions with the government, this study verifies the the degree to which a smart public library creates values that encourage public participation in the government and, consequently, open government. A distribution frequency of 116 survey responses from users and public officials was shown by the analysis results. To avoid the possibility of positivity biases that could indicate public officials' propensity to inflate the positive (agree) replies, the distribution frequency analysis for the officials and users were carried out independently. As a result, the outcome raises interesting questions about the compelling factors that motivate Indonesian public libraries to uphold values by offering tools, services, and initiatives that improve the public's ability to interact with the government even in light of the previously mentioned specific limitation. The author **Djoko Sigit Sayogo;, Sri Budi Cantika Yulia; Wiyono (3) 2022**, concludes that, based on information gathered from an Indonesian public library survey, the results confirm

that the public library creates value by giving people the means, the tools, and enhanced online engagement opportunities with the government.

The author **Samir Mendhe; Ritik Dhabale; Kaushik Hiranwar; Pratik Deshmukh; Chetna Katre; Shanu Rahule, (4) 2023**, in their paper A Review Paper On IOT Based Library Light Management System, speaks about the emerging technology that could and will bring about the better society we have all been hoping for is the Internet of Things. Universities and colleges employ traditional lighting systems in their libraries, which need a switch to change the lighting. This will result in needless electrical waste. Using an Arduino and a motion sensor, the system analyses user movements and adjusts lighting in various library areas.

Various advantages were proposed system are: **Library lights that switch on and off automatically:** The Automatic Library Lighting feature of the IOT-Based Library Light Management System allows you to program a room's lighting to turn on when a visitor arrives and off when they leave.

Saving funds: People enter a room, turn on the light, and then, surprisingly often, fail to turn it off before they leave. The occupancy sensors on the lights, which turn on when someone enters the building and off when no one is there, help us save money on our electricity costs.

The author **Samir Mendhe; Ritik Dhabale; Kaushik Hiranwar; Pratik Deshmukh; Chetna Katre; Shanu Rahule, (4) 2023**, concludes in his study that the proposed project when completed and the system is functioning as it should, the light above the bookshelf will turn on automatically when someone enters the library to look for a book, and it will turn off automatically when that person takes a book off the shelf and leaves. Minimal power use in libraries is made possible by the Smart Intelligent Library Lighting system

The paper titled, Harnessing Coopetition for the Survival of Nigerian Public Libraries: Role of Smart Technologies, authored by **Adebowale Jeremy Adetayo, (5) 2023**, discusses about the increasingly, invasive and disruptive technologies, shifting patron needs, and alternative information sources offering similar library services are having an impact on public libraries. The author discusses the theoretical basis of this study is the resource-based approach. From the perspective of strategic management, this analysis looks into the competitive advantages that come from organizational resources. The author also speaks about how examining an organization's resources and capabilities relates to its performance is the goal of the resource-based perspective. The author **Adebowale Jeremy Adetayo, (5) 2023**, further says, libraries can adopt this theory. Given that public libraries can survive by utilizing their resources and capacities to form collaborative strategies, they can embrace and modify resource-based theory to compete with their technological adversaries. For public libraries to stay competitive in the information and knowledge age, this study should act as a springboard for them to think about implementing cooperative practices. More investigation is advised into potential coopetition models including large internet businesses, financial institutions, and public libraries as concluded by the author **Adebowale Jeremy Adetayo, (5) 2023**.

The author, **Hamad, F., Al-Fadel, M. and Shehata, A.M.K. (6) (2023)**, in their paper the level of digital competencies for the provision of smart information services at academic libraries in Jordan discuss academic libraries' need to adapt to the changing information needs of their more tech-savvy users and prefer quick, remote access to information, by implementing emerging technologies in place of more traditional services and procedures.

Academic libraries are currently adopting smart technologies as a trend. The purpose of this study is to examine the extent to which university libraries in Jordan are implementing smart information services. It also sought to look into the relationship between the degree of digital competency possessed by library employees and the sophistication of the information services provided by the libraries.

The author **Hamad, F., Al-Fadel, M. and Shehata, A.M.K. (6) (2023)**, discuss libraries' need to change and keep up with the rising digital transformation of library services and the growing emphasis on developing smart communities. To do this, they must make improvements to both their environmental and service offerings. A review of the literature in existence indicated that there were few studies about the degree of digital competencies and skills held by librarians at Jordanian university libraries to establish smart information services at their establishments. To help the library implement and offer smart information services, it is necessary to look into the level of digital competency among librarians in Jordanian academic libraries.

Academic libraries in Jordan have a generally moderate degree of smart information service implementation, and their librarians possess a moderate level of digital competencies and skills. The respondents considered SDI to be the main intelligent information service that libraries presently provide. The libraries also provided smart information services through RFID and QR codes. Academic libraries still don't have access to some more cutting-edge technologies, such as augmented reality. Researchers found that librarians gave excellent ratings to their computing, web and mobile capabilities, digital content management, and database searching abilities when it came to using art programs as concluded by the author **Hamad, F., Al-Fadel, M. and Shehata, A.M.K. (6) (2023)**.

3. OBJECTIVES

The objectives of implementing smart lighting for cubicles and book racks in libraries encompass various aspects aiming to enhance functionality, user experience, and sustainability. Some key objectives include:

1. **Task-Specific Illumination:** Tailoring lighting to meet specific tasks performed in cubicles and at book racks, ensuring optimal visibility without causing glare or discomfort to individuals.
2. **Energy Efficiency:** Maximizing energy savings through automated controls, such as motion sensors, dimming capabilities, and scheduling, to reduce unnecessary power consumption when spaces are unoccupied or natural light is available.
3. **User Comfort and Productivity:** Creating an environment that fosters concentration, productivity, and well-being by providing adjustable lighting settings that cater to individual preferences and work/study requirements.
4. **Adaptability and Flexibility:** Offering customizable lighting solutions that adapt to changing needs, such as adjustable color temperatures or brightness levels, catering to diverse tasks and users.
5. **Integration with Smart Building Systems:** Facilitating integration with broader smart building systems for seamless operation, data sharing, and synergy with other intelligent technologies within the facility.

By aligning smart lighting strategies with these objectives, the implementation in cubicles and library book rack areas can significantly enhance the overall user experience, improve efficiency, and contribute to a more sustainable and adaptable environment.

4. NEED FOR THE STUDY

The implementation of smart lighting in cubicles and library book racks caters to several specific needs that conventional lighting systems may not fully address:

4.1 Task-Oriented Illumination: Cubicles and library book racks often require focused lighting for reading, studying, or working on specific tasks. Smart lighting can provide adjustable brightness levels and precise illumination to accommodate these activities efficiently.

4.2 Customizable Lighting Solutions: Different individuals have varying preferences for lighting intensity and color temperature. Smart lighting allows customization to meet these diverse needs, ensuring comfort and productivity for users.

4.3 Energy Efficiency and Sustainability: Conventional lighting systems often lack the ability to optimize energy usage. Smart lighting incorporates sensors and automated controls, such as motion sensors and scheduling, to minimize energy consumption when spaces are unoccupied or when natural light is available.

1. **Adaptability to Changing Environments:** Libraries often have changing lighting needs based on the time of day, weather conditions, or occupancy levels. Smart lighting systems can adjust to these variations dynamically, ensuring consistent and adequate illumination throughout the day.

2. **Space Optimization:** Efficiently illuminating specific areas within cubicles and along book racks ensure that users can access resources easily without compromising on safety or comfort.

3. **Integration with Building Systems:** Integration with broader smart building systems allows lighting to synchronize with other technologies, enhancing overall operational efficiency and enabling a more cohesive smart environment.

By addressing these specific needs, smart lighting systems offer a comprehensive solution tailored to the requirements of cubicles and library book rack areas, promoting efficiency, comfort, and adaptability within these spaces.

5. DISCUSSION

5.1 Task-specific illumination refers to the concept of tailoring the lighting conditions in a given environment to optimize performance for a specific task or set of tasks. This approach recognizes that different activities or applications may benefit from unique lighting conditions to enhance visibility, comfort, and efficiency. Here are some aspects to consider in the discussion of task-specific illumination:

a) Task Performance:

i) Optimal Lighting for Tasks: Different tasks require varying levels and types of illumination. For example, detailed work may benefit from brighter and more focused lighting, while ambient, softer lighting may be suitable for relaxation or general activities.

b) Human Factors:

i) Visual Comfort: Task-specific illumination takes into account the comfort of individuals performing the task. Glare, contrast, and color temperature are important factors that influence visual comfort and should be tailored to the specific requirements of the task.

c) Technology Integration:

i) **Smart Lighting Systems:** The integration of smart technologies, such as sensors and automation, allow for real-time adjustments in lighting conditions. This not only enhances the efficiency of task-specific illumination but also contributes to a seamless and user-friendly experience.

5.2 Energy Efficiency

Energy efficiency is a critical aspect of modern living, and discussions around it often center on optimizing the use of energy resources to reduce waste and environmental impact. Here are key points to consider in a discussion on energy efficiency:

a) Environmental Impact:

i) **Reducing Carbon Footprint:** Energy efficiency is directly tied to a reduction in greenhouse gas emissions. By using energy more efficiently, we can decrease the overall environmental impact and contribute to mitigating climate change.

ii) **Cost Savings:** Improved energy efficiency can lead to cost savings for individuals, businesses, and governments. Investments in energy-efficient technologies and practices often result in long-term financial benefits through reduced energy bills and operational expenses.

b) **Technology and Innovation: Driving Technological Advances:** The pursuit of energy efficiency encourages research and development in new technologies. This, in turn, drives innovation, leading to the creation of more efficient devices and system.

5.3 User Comfort and Productivity

i) Ergonomics in Design:

a) Talk about the ways that ergonomic design ideas improve user comfort. This covers both digital ergonomics such as intuitive interfaces and navigation and physical comfort such as well-made workstations and seats.

ii) Customization and Personalization

Consider how modifications influence user comfort. Comfort and a sense of belonging can be improved by systems or products that let customers customize their experience, whether it's through changing settings or preferences.

5.4 Adaptability and Flexibility

i) **Activity-Based Lighting:** Libraries are adaptable spaces for a variety of uses, including study sessions, reading groups, presenting, and group discussions. By creating the right lighting conditions, a flexible lighting system can adjust to these activities. For example, brighter lighting could work well in study areas, but softer lighting might be better in reading areas.

ii) **Accessibility Features:** Speak about how features that make a product more accessible help people with different requirements feel more at ease. This includes adaptable font sizes to suit different users, screen readers, and text-to-speech capabilities.

5.5 Integration with Smart Building Systems

i) **Automated Book Tracking:** RFID (Radio Frequency Identification) technology can be integrated with library systems to facilitate effective book tracking, which in turn makes it simpler for users to find and check out books. RFID tags can also be utilized to expedite inventory management procedures and prevent stealing.

ii) The optimization of energy use in libraries can be achieved through the implementation of smart lighting solutions. Consumption of energy can be avoided by using occupancy sensors, which can identify areas that are empty and automatically modify lighting levels. Furthermore, capable of controlling air conditioning and heating systems, smart thermostats not only save energy but also provide the best possible comfort for library patrons.

CONCLUSION

There are a lot of advantages for installing smart lighting systems in libraries for book racks and cubicles. Libraries can minimize energy usage, cut expenses, and improve patron comfort by implementing occupancy sensors and controlled lighting controls.

Occupancy sensors in smart lighting systems allow them to recognize when book racks or cubicles are empty and modify lighting levels to save energy while the system is idle. This promotes the library's sustainability initiatives in addition to helping with conserving electricity.

In addition, by providing the right amount of lighting for various tasks, automatic lighting controls can improve user experience overall. For example, if users are reading in cubicles, brighter lighting can be turned on, and if they are browsing bookshelves and darker lighting can be adjusted.

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