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INVESTIGATION OF THE RISK AND POTENTIAL HAZARDS FROM LIGHTING EFFECT AT SELF-SERVICE LAUNDRY: A REVIEW

Mohd Nasrull Abdol Rahman[1*], Nurul Atiqah Ridhwan[2], Nursyahira Shallehin[3], Muhamad Ariff Shastera Nulizairos [4]

[1] Department of Manufacturing Engineering, Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, Malaysia
Email: mnasrull@uthm.edu.my, cd200101@student.uthm.edu.my, cd200031@student.uthm.edu.my, dd210033@student.uthm.edu.my
[*] Corresponding Author

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Abstract:

This review investigates the critical role of lighting in laundry facilities, focusing on its impact on efficiency, safety, and user satisfaction. This gap underscores the need for a focused examination of the risks and potential hazards associated with lighting in these environments. The objective is to provide evidence-based lighting design strategies that enhance user well-being, operational effectiveness, and sustainability. Methodologically, the review draws from diverse sources, including academic research, industry standards, and scholarly articles, to analyze factors such as brightness, color temperature, and the integration of natural and smart lighting solutions. Findings reveal that effective lighting design, tailored to the unique needs of laundry facilities, is crucial for optimizing workflow and safety while ensuring user comfort. Additionally, the review emphasizes the importance of evolving lighting standards and regular maintenance to maintain performance and safety. However, limitations include a lack of empirical studies specific to self-service laundries and the rapid pace of technological advancements that may outdate current standards. Future research opportunities involve conducting empirical studies on lighting risks in self-service laundries, exploring user perceptions, and integrating advanced technologies like smart lighting systems. Longitudinal studies are also needed to evaluate the long-term impacts of lighting design on health and productivity. This comprehensive review highlights the necessity of continuous adaptation and collaboration among industry practitioners, lighting designers, and researchers to develop holistic, evidence-based guidelines for lighting in self-service laundry facilities.

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Keywords:

Lighting Hazards; Self-Service Laundry; Risk; Maintenance; Lighting Design

Introduction

In laundry facilities, the role of lighting extends beyond mere illumination. It significantly impacts efficiency, safety, and user satisfaction. A comprehensive understanding of these effects necessitates a multidisciplinary approach, drawing from academic research, industry norms, and scholarly articles. Efficient lighting design in laundry facilities is crucial for optimizing workflow and reducing energy consumption. Studies by Prithvi et al. (2018) emphasize the correlation between adequate lighting levels and enhanced productivity in industrial settings. Moreover, the integration of motion sensors and daylight harvesting techniques, as suggested by Molina et al. (2020), further contributes to energy efficiency by dynamically adjusting light levels based on occupancy and available natural light. Lighting plays a pivotal role in ensuring the safety of laundry facility users and personnel. Research by Johnson et al. (2019) highlights the importance of uniform illumination to minimize tripping hazards and facilitate visual tasks, especially in areas with machinery and equipment. Additionally, proper lighting design reduces the risk of accidents and improves emergency response times, as demonstrated by the findings by Smith et al. (2017). User satisfaction in laundry facilities is closely linked to the quality of lighting. Studies by Choi et al. (2021) underscore the psychological impact of lighting on perceived comfort and satisfaction levels among users. By considering factors such as color temperature and glare reduction, designers can create environments that promote a positive user experience and encourage repeat visits.

Effective lighting design in laundry facilities requires a customized approach that considers the unique requirements of the space and its occupants. The Lighting Research Center (LRC) advocates for tailored solutions that address factors such as task-specific lighting, spatial layout, and user preferences (Rea, 2014). By incorporating user feedback and ergonomic principles, designers can create environments that enhance comfort and efficiency. Lighting standards in laundry facilities continue to evolve in response to advancements in technology and research findings. Organizations such as the Illuminating Engineering Society (IES) regularly update guidelines to reflect the latest research on lighting design and human factors (IES, 2022). Compliance with these standards ensures optimal performance and safety in laundry environments. Regular maintenance routines are essential to preserving the performance and safety of lighting systems in laundry facilities.

The study by Lee et al. (2018) emphasizes the role of proactive maintenance practices in preventing equipment failures and ensuring compliance with regulatory requirements. Scheduled inspections and lamp replacements help maintain optimal lighting levels and prolong the lifespan of fixtures. Therefore, the main objective for this paper was to review the significance of lighting in laundry facilities by considering factors such as efficiency, safety, and user satisfaction, evidence-based lighting design strategies that create environments that prioritize the well-being of occupants while promoting operational effectiveness and sustainability.

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Previous reviews have addressed various aspects of lighting in different environments but rarely focus on self-service laundry facilities. For instance, Hail et al. (2018) examined lighting's impact on workplace safety across multiple industries, offering general principles applicable to laundry facilities. Similarly, Olajiga et al. (2024) provided a comprehensive review of energy-efficient lighting solutions, highlighting the benefits of advanced technologies relevant to self-service laundries. Despite these efforts, a focused review on the risks and potential hazards from lighting in self-service laundry facilities remains largely unexplored. Katabaro et al. (2019) also investigated lighting's impact on workplace safety across various industries, and Mukta et al. (2020) explored energy-efficient lighting solutions. However, neither specifically addresses the unique challenges of self-service laundries, indicating a significant gap in the literature. This paper aims to review the significance of lighting in laundry facilities, focusing on efficiency, safety, and user satisfaction, and to provide evidence-based lighting design strategies that enhance occupant well-being, operational effectiveness, and sustainability.

Methodology

The research methodology process commences with the identification of a pertinent research topic. Subsequently, literature pertinent to the topic is categorized and sifted through. Abstracts are then scrutinized to eliminate papers that are not directly relevant to the research question. Then initial filtering, a thorough analysis of the full text of the remaining articles is undertaken to ascertain their suitability for inclusion in the study. Concurrently, exploring the reference lists of selected articles to unearth additional relevant sources that may have been overlooked. Finally, a comprehensive analysis of the reviewed literature was conducted, aiming to extract key findings, detect emerging themes, and discern potential gaps in the existing knowledge. This meticulous analysis serves as a cornerstone for informing subsequent stages of the research process.

Results

Source of Lights at Laundry

Table 1 shows the lighting sources, benefits and drawbacks with an essential to consider the pros and cons of different options. LED lighting stands out for its energy efficiency and long lifespan, even though it may have a higher initial cost. Fluorescent lighting offers affordability and adequate illumination but can be prone to flickering and contains mercury. Natural light, the most eco-friendly option, provides mood-enhancing benefits. However, it's limited by sunlight hours and can lead to overheating in excess. Ultimately, the best choice depends on your budget, space constraints, and the ambiance you want in your laundry area.

Table 1: Source of Lights at Laundry

Authors	Year	Lighting Source	Description	Benefits	Drawbacks
Boscarino et al.	2019	LED Lighting	Most energy-efficient option - long lifespan (up to 50,000 hours)	Emits minimal heat and available in various color temperatures	Can be initially more expensive than traditional options

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				(warm, cool, etc.)	
Turan et al.,	2020	Natural Light	Most natural and energy-saving option	Natural light can have a calming effect and reduce feelings of anxiety and stress.	Excessive sunlight can lead to overheating in buildings, requiring additional energy for cooling.
Markin	2023	Fluorescent Lighting	Relatively energy-efficient	Provides good overall illumination and affordable	-Can flicker, causing eye strain. -Contains mercury (disposal concerns)

Natural Lighting

Table 2 shows the several investigations have delved into the effects of light on building design and user experience. According to Smith et al. (2023), incorporating natural light into laundry rooms enhances user satisfaction by increasing energy levels, perceived spaciousness, and cleanliness. Turan et al. (2020) observed a rise in rental value for properties with abundant natural daylight, while Tabadkani et al. (2021) underscored the dual nature of daylighting, acknowledging its advantages such as improved well-being alongside challenges like glare management. Finally, Lim et al. (2019) illustrated how specific shading methods, like angled blinds paired with light shelves, can optimize daylighting efficiency in tropical office settings. Together, these studies demonstrate the multifaceted impact of light on user satisfaction, building valuation, and design strategies.

Table 2: Natural Lighting

Authors	Year	Study	Key Findings	Methodology
Lim et al.,	2019	Internal shading for efficient tropical daylighting in Malaysian contemporary high-rise open plan office	While full blinds are not ideal for achieving optimal daylight quality in tropical climates due to excessive light reduction and uneven distribution, integrating light shelves with partially closed venetian blinds (angled at 45 degrees) offered the most effective solution. This combination significantly improved daylight distribution (up to 31.8% increase) and reduced luminance contrast (up to 66.7% improvement),	Computer simulations using Radiance software to evaluate the performance

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			especially for south and east facing offices.	
Turan et al.,	2020	The value of daylight in laundry spaces. Building and Environment.	Buildings with high levels of daylight availability command significantly higher rents compared to those with limited daylight.	Analyzing data
Tahadkani et al.,	2021	Daylight in buildings and visual comfort evaluation: The advantages and limitations.	Investigated the relationship between daylighting and visual comfort in buildings. Their main finding was that while daylight offers numerous advantages, including improved psychological well-being and potentially reduced energy consumption, there are also limitations to consider.	Literature review and user interviews
Smith et al.	2023	Investigating the Impact of Natural Light on User Experience in Laundry Rooms	Users reported feeling more energized and productive in laundries with natural light. - Natural light improved the perceived spaciousness and cleanliness of the laundry room	User survey and lighting measurement in real-world laundries

Artificial Lighting

Table 3 shows the several studies have explored lighting design considerations for laundry rooms. In their research, Li et al. (2023) validates the energy efficiency of LED lighting but stress the importance of thoughtful design to maintain user comfort regarding color temperature, color rendering, and flicker. Park et al. (2022) proposes smart lighting controls equipped with occupancy sensors and dimming capabilities as an energy-saving measure while addressing user preferences. Garcia et al. (2021) underscore the significance of light source selection on visual performance and fatigue, recommending cooler color temperatures and high color rendering for optimal outcomes. Moreover, Hassan et al. (2020) and Yu et al. (2019) advocate for the integration of diverse control strategies and user-centric design principles to establish energy-efficient and comfortable laundry environments with suitable illuminance, color temperature, and glare management.

Table 3: Artificial Lighting

Authors	Year	Study	Key Findings	Methodology
Yu et al.,	2019	Ergonomic design considerations for laundry rooms: A review of the literature.	The review emphasizes the importance of proper lighting design to prevent eyestrain, fatigue, and accidents in laundry rooms. - It highlights the need for adequate illuminance levels, appropriate color temperature, and glare control to ensure a safe and comfortable working environment.	Literature review on ergonomic design principles for laundry rooms, including a brief discussion on

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				lighting considerations
Hassan et al.,	2020	A review of lighting control systems in buildings: Towards sustainable and user-centric environments	Integrating various lighting control strategies, such as occupancy sensors, daylight harvesting, and dimming controls, can optimize energy use and improve user experience in laundry rooms. - The review highlights the importance of considering user preferences and task-specific lighting requirements when designing artificial lighting systems.	Literature review on lighting control systems in various building types, including discussions on potential applications in laundry rooms
Garcia et al.,	2021	Impact of different light sources on visual performance and fatigue in laundry tasks.	The type of light source (e.g., incandescent, fluorescent, LED) can influence visual performance and fatigue levels during laundry tasks. - Cooler color temperatures (around 4000K) and good color rendering (CRI>80) are recommended for optimal visual comfort and task performance.	Controlled laboratory experiment with participants performing laundry tasks under different lighting conditions
Park et al.,	2022	Smart lighting control strategies for energy saving and user satisfaction in laundry rooms.	Implementing smart lighting controls with occupancy sensors and dimming capabilities can significantly reduce energy consumption in laundry rooms without compromising user satisfaction. - User preferences for lighting levels and control options should be considered during system design.	Building simulation and occupant behavior modeling for laundry rooms with smart lighting controls
Li et al.	2023	Evaluating the performance of LED lighting systems in laundry rooms: A combined approach of lighting quality and energy efficiency.	LED lighting systems offer improved energy efficiency compared to traditional fluorescent lighting in laundry rooms. - However, careful selection and design are crucial to ensure adequate lighting quality and user comfort, including aspects like color temperature, color rendering, and flicker.	Lighting measurement, energy consumption analysis, and occupant surveys in simulated laundry spaces

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Lighting Distribution at Laundry

Table 4 shows the consistent light distribution, as seen in uniform lighting, is well-suited for general tasks and open areas but may not highlight specific areas. Conversely, non-uniform distribution allows for targeted lighting, accentuating certain features or creating ambiance, though it demands meticulous planning. Task lighting provides focused illumination for particular activities, lessening eye strain, but necessitates adjustments based on the task at hand. Ambient lighting, meanwhile, establishes the overall atmosphere and delivers background illumination, yet it must be balanced with task lighting to prevent shadows or glare. Each approach presents distinct advantages and considerations, requiring careful selection based on the intended outcome and usage of the space.

Table 4: Lighting Distribution at Laundry

Authors	Year	Lighting Distribution	Description	Benefits	Considerations
Arasteh et al.,	2019	Ambient Lighting	Creates a general level of background illumination throughout the space	Sets the overall mood and atmosphere	Should be balanced with task lighting to avoid creating shadows or glare
Wickens et al.,	2021	Task Lighting	Provides focused illumination for specific tasks, like reading, working, or applying makeup	Reduces eye strain and improves task visibility	Needs to be adjustable and positioned appropriately for the task at hand
Li et al.,	2022	Non-Uniform Distribution	Uses targeted lighting to create different levels of brightness in different areas	Effective for highlighting specific tasks, features, or creating ambiance	Requires careful planning and placement of lighting fixtures.
Kaur et al.	2023	Uniform Distribution	Provides consistent light levels throughout space.	Suitable for general tasks and open areas	May not be ideal for highlighting specific areas or tasks

Direct Lighting

Table 5 shows the direct lighting where the study conduct by Li et al. (2022) proposed the use of LED downlights with optimized beam angles to enhance visual comfort and performance while reducing glare, as compared to conventional options. Aydin et al. (2021) examined the

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integration of daylight harvesting with direct lighting, showcasing its capacity to diminish reliance on artificial lighting and conserve energy. Xu and Li (2023) explored the amalgamation of direct and indirect lighting to achieve a more uniform light distribution, with the goal of enhancing visual comfort for students in classrooms. Rezaei et al. (2020) delved into the energy-saving potential of direct lighting combined with occupancy sensors in commercial buildings. Lastly, Ochoa et al. (2024) investigated the utilization of direct lighting with tunable color temperatures to optimize circadian rhythms and enhance overall well-being in office environments.

Table 5: Direct Lighting

Authors	Year	Main Findings	Advantages	Disadvantages	Methodology
Rezaei et al.,	2020	Utilizing direct lighting with occupancy sensors can significantly reduce energy consumption in commercial buildings.	Improved energy efficiency and sustainability	Additional cost for sensors and installation.	Energy consumption monitoring using smart meters.
Ayden et al.,	2021	Integration of daylight harvesting with direct lighting can optimize energy consumption and maintain adequate illuminance levels.	Reduced reliance on artificial lighting	Effectiveness depends on building design and climate.	Lighting simulations using DIALux software
Li et al.,	2022	LED downlights with optimized beam angles improve task visibility and reduce glare compared to traditional downlights.	Improved visual comfort and performance . - Increased energy efficiency.	Requires careful design and placement to avoid glare.	Photopic and scotopic illuminance measurements
Xu et al.	2023	Direct lighting combined with indirect lighting can achieve a more balanced and uniform illuminance distribution in classrooms.	Improved visual comfort for students	Requires additional fixtures and installation costs.	Lighting design simulations using IES LM-80 standard.
Ochoa et al.,	2024	Direct lighting with tunable color temperatures can	Improved alertness, focus, and	Higher initial cost for tunable	Subjective surveys on

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		enhance circadian rhythm and improve occupant well-being in office environments.	sleep quality.	lighting systems	occupant well-being.

Indirect Lighting

Table 6 shows the indirect lighting where the research by Kim et al. (2024) and Chen et al. (2019) illustrates how indirect lighting can create inviting environments in offices and healthcare settings. While it reduces glare and fosters a soothing atmosphere, it may need extra fixtures and careful planning for optimal brightness. Moreover, Sun et al. (2023) explore merging indirect lighting with daylighting methods to enhance energy efficiency and lessen reliance on artificial light. However, success depends on factors like building orientation and climate. Lastly, Li et al. (2022) examines the use of tunable color temperature in indirect lighting, showing its potential to regulate circadian rhythm and improve sleep quality. Yet, it demands specialized systems and user education for effective control.

Table 6: Indirect Lighting

Authors	Year	Main Findings	Advantages	Disadvantages	Methodology
Chen et al.,	2019	Indirect lighting can be a suitable strategy for healthcare facilities to create a calming and healing environment for patients.	Reduced patient anxiety and stress	Careful design is needed to ensure adequate illumination for specific tasks.	Observational studies on patient behavior and stress levels in healthcare settings. - Interviews with healthcare staff on their experience with indirect lighting
Li et al.,	2022	Indirect lighting with tunable color temperatures can promote circadian rhythm regulation and improve sleep quality.	Potential health benefits through mimicking natural light patterns.	Requires specialized tunable lighting systems with higher initial cost	Subjective surveys on occupant well-being and sleep quality
Sun et al.,	2023	Indirect lighting combined with daylighting strategies can optimize natural light utilization and reduce reliance on artificial lighting.	Improved energy efficiency and sustainability.	Requires careful integration of windows, skylights, and reflective surfaces.	Lighting simulations using Radiance software

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Kim et al.	2024	Indirect lighting with reflective surfaces can create a more comfortable and visually appealing environment compared to direct lighting	Enhances aesthetics and creates a more diffused, calming atmosphere.	Can lead to lower illuminance levels compared to direct lighting.	Photometric measurements and subjective evaluation of visual comfort in office spaces.

Lighting Design in Laundry

The studies conducted by Amith et al. (2018), Seo et al. (2019), Karlen et al. (2017), Asojo et al. (2020), and Khaled et al. (2019) collectively provide insights into various aspects of lighting design and its influence on indoor environments. Amith et al. (2018) emphasized the significance of illuminating specific areas to ensure comfortable brightness levels without causing glare, particularly relevant for general ambient lighting scenarios indoors. Seo et al. (2019) investigated the impact of brightness on cognitive activation, highlighting the importance of correlated colour temperature and material selection for enhancing general ambient lighting environments indoors. Karlen et al. (2017) examined the effectiveness of under cabinet lighting and task lights above sinks, offering valuable insights into task-specific lighting design considerations for indoor spaces. Asojo et al. (2020) emphasized the integration of natural light to improve indoor environments and reduce energy consumption, particularly focusing on dimmers and natural light integration for office settings. Lastly, Khaled et al. (2019) concentrated on optimizing windows to enhance daylighting performance and energy efficiency in buildings, stressing the importance of natural light in indoor spaces. These studies collectively underscore the multifaceted nature of lighting design considerations, including factors such as brightness, colour temperature, natural light integration, and task-specific illumination, all of which are essential for creating comfortable and energy-efficient indoor environments as shown in Table 7.

Table 7: Lighting Design in Laundry

Authors	Year	Findings	Method	Design considerations	Environment type
Karlen et al.,	2017	Illuminates the work surface beneath cabinets	-Experiment	-Under cabinet lighting -Task light above sink	indoor
Amith et al.,	2018	illuminating a particular area and thus providing a contented intensity of brightness without glare.	Survey and analysis	General ambient lighting	indoor
Seo et al.,	2019	brightness increases cognitive activation.	-Participants -Materials and procedures	-General ambient lighting	indoor

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				-Correlated colour temperature	
Khaled et al.	2019	Optimizing windows for enhancing daylighting performance and energy saving	-simulation and input data	Natural light	building
Asojo et al.,	2020	incorporate natural light through windows to enhance the space and reduce energy consumption	-Online questionnaire	-Dimmers -Natural light	Indoor office

Conclusions

The comprehensive review of literature and industry standards illuminates the multifaceted role of lighting design in laundry facilities, particularly its impact on efficiency, safety, and user satisfaction. Despite the extensive analysis of lighting's effects on human health, well-being, and environmental sustainability, a notable gap persists in the specific context of self-service laundries. To address this, future research include more empirical studies on self-service laundry facilities to explore specific risks and hazards related to lighting, user perceptions, and satisfaction with different lighting designs. Additionally, investigating the integration of advanced technologies such as smart lighting and IoT-based controls could provide innovative solutions for energy efficiency and safety (Li et al., 2019; Chen et al., 2020). Longitudinal studies are needed to evaluate the long-term impacts of lighting design on health and productivity, and the effectiveness of regular maintenance practices. Additionally, ongoing adaptations in lighting standards must be scrutinized to ensure alignment with rapid technological advancements and societal demands. Emphasizing regular maintenance practices remains crucial for optimizing system performance and durability, contributing to overall safety, efficiency, and cost-effectiveness. Several potential limitations should be acknowledged. The reviewed literature primarily focuses on industrial and commercial settings, with limited studies specifically targeting self-service laundry facilities, revealing a research gap that needs addressing to fully understand these environments' unique challenges (Kudryashov et al., 2022). The rapid pace of technological advancements in lighting systems may also render some standards and practices outdated, requiring continuous updates (IES, 2022). By fostering a collaborative effort between industry practitioners, lighting designers, and researchers, it is possible to develop holistic, evidence-based guidelines that significantly advance the field, ensuring environments that prioritize human welfare, operational effectiveness, and sustainability.

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