DOI: 10.71317/jgst.2.9(s2).2026.656
Journal of Global Social Transformation
Journal homepage: https://rjsaonline.org/index.php/JGST

# Integration of Smart Lighting for Energy-Efficient Residential Interiors: Residents' Perceptions

**Itrat Ul Zahra[1], Umer Mahboob Malik[2], Alveena Fatima[3]**
[1] MS Scholar, SADU, Institute for Art and Culture, Lahore.
Email: itratulzahra@gmail.com
[2] Assistant Professor, SADU, Institute for Art and Culture, Lahore.
Email: umer.mahboob@iac.edu.pk
[3] Assistant Professor, SADU, Institute for Art and Culture, Lahore.
Email: alvina.fatima@iac.edu.pk

**ARTICLE INFO**

**Submission:**
August 03, 2026
**Revised:**
August 18, 2026
**Accepted:**
September 06, 2026
**Available Online:**
September 22, 2026

**Keywords:**
Smart lighting, energy efficiency, residential interiors, residents' perceptions, smart home technology, sustainable interiors.

**Corresponding author:**
**Itrat Ul Zahra**
**Email:**
**itratulzahra@gmail.com**

**ABSTRACT**

The smart lighting technology is increasingly adopted in residential interiors as it can assist with automatic control, dimming, presence sensors, daylight adjustment and remote operations. Although, energy saving potential of smart home technologies and smart home lightings have been discussed in previous studies, however there is limited research regarding the perception of residents and factors that affect its adoption particularly in residential interiors. This study was conducted to examine the sustainability and energy efficiency of smart lighting in homes in residents' perception. A quantitative research approach was used to collect data from participants, using questionnaire statements based on five point likert scale. The responses were analyzed using frequencies and percentages presented through charts and tables. The findings indicate that most of the residents showed positive perception regarding integration of smart lighting systems in residential interiors. Almost all respondents agreed and showed positive response towards the use of automatic switching, light dimming, presence sensor lights, and daylight responsive lighting to reduce unnecessary consumption of energy. Although strong preference was found for mobile phone control, voice control and occupancy based lighting. The study concludes that smart lighting is preferred by residents when it offers energy saving benefits, convenience, and affordability. The findings suggest to consider residents needs when integrating smart lighting systems into residential interiors.

## Introduction

### Research Background

The increasing smart technologies use in residential environments has improved energy efficiency, comfort, and functionality of interior spaces by creating new possibilities. A connected system is used in smart home technologies, which allows household devices to interact with each other by monitoring conditions and respond automatically to users. For sustainable use, residents' knowledge about smart energy management is significant (Hakawati B. et al., 2024). Particularly, smart lighting is most relevant in residential interiors, because it affects both the electricity consumption and visual quality of a space. Smart lighting systems includes daylight sensors, automatic dimming, occupancy sensors, voice control lighting, or mobile control lighting to adjust lighting according to the user comfort.

The relationship between smart technology and residential interior use has been increasingly examined in recent researches. Smart home technologies are significantly increasing to be used in services such as energy management, convenience, and comfort (Hansen A. R. et al., 2024). The important considerations in smart home technologies include maintenance, detection range, privacy, and sensor placement (Olsson T. et al., 2024).

**Problem Statement**

The smart lighting technologies are becoming increasingly available in residential environments, with features like automatic dimming, occupancy detection, voice control, and control through mobile phones. However, their success in integration in residences depends over the technology awareness and willingness of adoption of residents (Hakawati B. et al., 2024). Although previous researches has explored the significance and potential of smart home technologies, but there is limited study regarding the perception and preferences of residents about the smart lighting use in residents. The adoption of smart lighting can significantly support energy savings, in which resident behavior plays significant role (Mousa A. et al., 2024). The relationship between smart home technologies and energy consumption can differ depending on the use of residents and technology type (Hansen A. R. et al., 2024). Therefore, it is significant to comprehend residents' perception regarding usefulness, affordability, comfort, and energy efficient potential of smart lighting.

**Research Questions**

- How residents perceive the role of smart lighting in residential interiors in improving energy efficiency?
- What are residents' preferences and barriers regarding adoption of smart lighting technologies in residential interiors?

**Research Objectives**

- To investigate how residents perceive the role of smart lighting in improving energy efficiency in residential interiors.
- To identify the preferences and barriers of residents, regarding the adoption of smart lighting technologies in residential interiors.

## Significance of Study

This study is important because it examines the smart lighting from perspective of the people residing in residential spaces. Rather than focusing on smart lighting technologically, the study examines the how residents perceive the usefulness of smart lighting and its ability to save energy consumption. The findings of this study may help interior designers to evaluate the expectations of residents regarding the smart lighting incorporated in residential spaces. Understanding the factors such as cost, usage, limited knowledge, and concerns about new technology may help designers in creating residential spaces which are not only energy efficient but also comfortable to use for residents.

## Literature Review

The increasing use of smart home technologies has significantly influenced how the residential spaces are designed and used. Connected devices such as sensors, automated systems, and voice control monitors are used in smart home technologies for making homes comfortable, convenient, and energy efficient. However, the use of smart home technologies is still emerging, therefore it is important to understand how these technologies integrate smart residential spaces with the users.

People are more likely to embrace smart technologies if they believe that it will be beneficial for them (Tak A. N. et al., 2023), also if technology becomes their habit it would be easier to adopt smart home technology. Smart home technologies may reduce energy consumption but its effectiveness depends on how it is used and understood by the residents (Stieglitz et al., 2023). Presence sensing lighting helps in reducing energy consumption in homes such as it turns lights on or off based on someone's presence (Sithravel R. et al., 2024).

When studying energy saving technologies in residences, it is important to evaluate and understand the preferences of users, their reasons, and problems (Antonopoulos, C. A., 2024). Each resident has their own preferences regarding smart home technologies adoption. To control individual lights, smart lighting can detect people location in a room, which helps in reducing unnecessary lighting and save energy consumption (Ning, C., 2024). However, accuracy of detection may be challenging if more than one people are present in same space. Although if lighting is adjusted according to peoples need, it can help in saving energy and user comfort.

To use energy saving technologies, awareness and education can encourage people (Hakawati, B., 2024), also energy can be saved with smart lighting systems like sensors which may support energy efficiency by controlling lights when needed. Smart lighting technologies may become more effective with users understanding, knowledge, and daily behavior. Different households use smart home technology differently, like younger households and people with technical knowledge uses smart technology effectively (Hansen, A. R., 2024), moreover, smart home technology does not always mean that energy consumption will reduce, but type and usage of technology also plays important role.

Smart lighting systems should focus on needs of occupants and the conditions of the environment (Wang, Y. et al., 2025), also the sensor lights can respond to the activities of the user, allowing to regulate accordingly. Future smart lighting should consider residents needs along with saving energy considering privacy, user needs, and accurate sensing. Instead of relying only on technicalities, smart home technologies should be studied according to residents' perspective (Chanda, R. C., 2025), also understanding the acceptance and avoidance of residents in using smart home technologies is important in developing sustainable homes.

The technologies such as sensors, automated lighting, smart HVAC systems, and adaptive shading can help in reduction of unnecessary energy consumption, allowing indoor spaces to respond according to user needs and environmental changes (Abdallah, S. A., 2026). Smart technologies may support energy efficiency, occupant comfort, and better environmental control.

### Research Gap

Although, previous studies have mainly focused on technicalities of smart home technologies, such as sensors, automated systems, and energy savings. Studies show that the success of smart home technologies is affected by the willingness, knowledge, and understanding of the residents. However, limited research has been done on the perception of residents about smart lighting technologies use in their residences. Therefore, this study aims to investigate the perception of residents regarding the use of smart lighting technologies such as, how it helps in energy saving, which features they prefer, and what other problems may hinder their usage. This may provide interior designers a better view of resident perception regarding smart home technologies.

## Methodology

## Research Design

This study uses a quantitative research design to evaluate the perception of residents regarding smart lighting in energy efficient residential interiors. A descriptive research approach was incorporated to collect data about preferences, views, and concerns of residents regarding smart lighting, using a likert scale questionnaire. The study focuses on residents' perception regarding energy efficiency of smart lighting and their preferred features to adopt.

### Participants and Sampling

The study was conducted with the people who live in residential homes. A convenience sampling technique was used in this study, allowing to reach residents which are easy to access and who participate willingly. The study aimed to collect 20 responses, participants were the adults from different backgrounds and were not required to provide personal information.

### Research Instrument

A structured questionnaire was used as main research instrument. The questionnaire contains 15 statements regarding smart lighting, energy efficiency, preferred features, and adoption barriers. Responds were taken using 5-point likert scale: Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree. The questionnaire included the views about smart lighting use in energy efficiency and the barriers such as cost and comfortability in usage of smart lighting technology.

### Data Collection Procedure

The questionnaire was distributed using online platforms. Participants were provided with brief explanation of the significance and purpose of the study. They were informed that the participation is voluntary and used for academic purposes and no personnel information was required. The participants filled the questionnaire according to their opinions and experiences. The collected responses were organized and prepared for analysis.

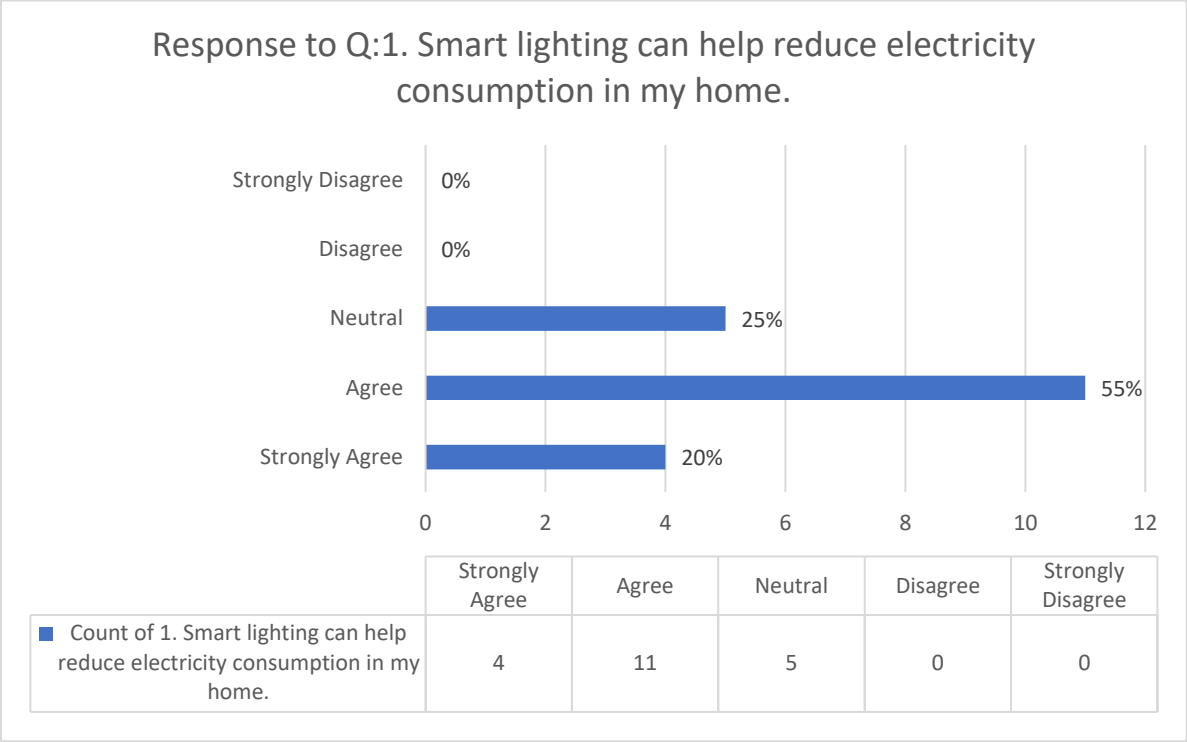
**Data Analysis**

The descriptive statistics was used to analyze data using frequencies and percentages shown by bar chart. Frequencies and percentages are used to show how participants responded to each question. The results are presented using bar charts. The analysis focuses on evaluating the perception of residents regarding smart lighting in residential spaces.

**Limitations of the Study**

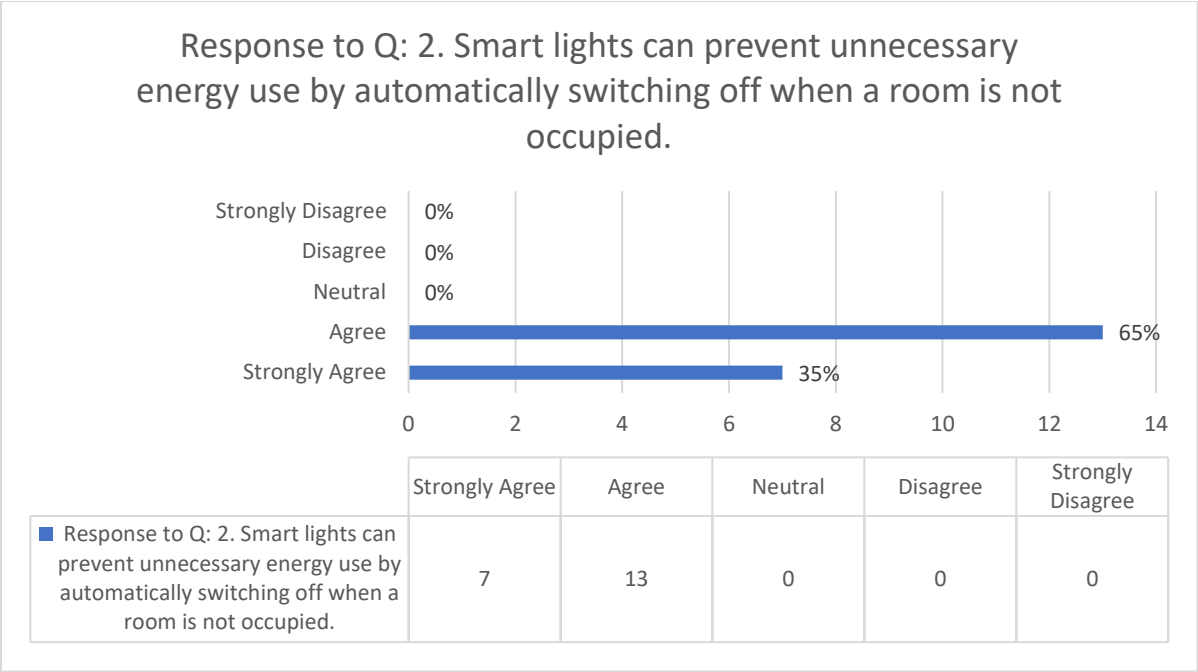
This study has few limitations. Firstly, the research is based on resident perception so it will not investigate the actual amount of energy saved by using smart lighting technology. Secondly, the sampling size is small which may not help to represent the views of many residents. Thirdly, the study only focuses on smart lighting, so the findings may not apply on other smart home technologies in residential homes.

## Results and Discussions



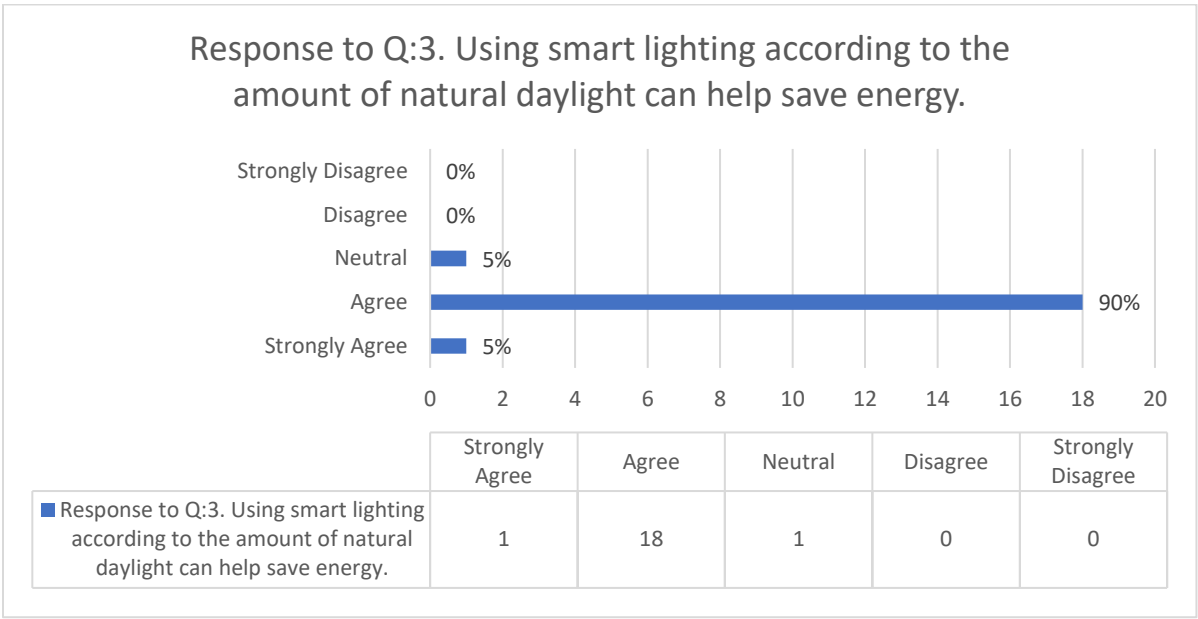

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Count of 1. Smart lighting can help reduce electricity consumption in my home. | 4 | 11 | 5 | 0 | 0 |

The results evaluate that 55% (n=11) agreed, and 20% (n=4) of the respondents strongly agreed to the statement that smart light can help in reduction of energy consumption in residential spaces, while 25% (n=5) remained neutral. Although no one disagreed or strongly disagreed. These results indicate that most of the participants agreed to the statement. Smart lighting can help in reducing energy consumption (Qiang et al., 2023).



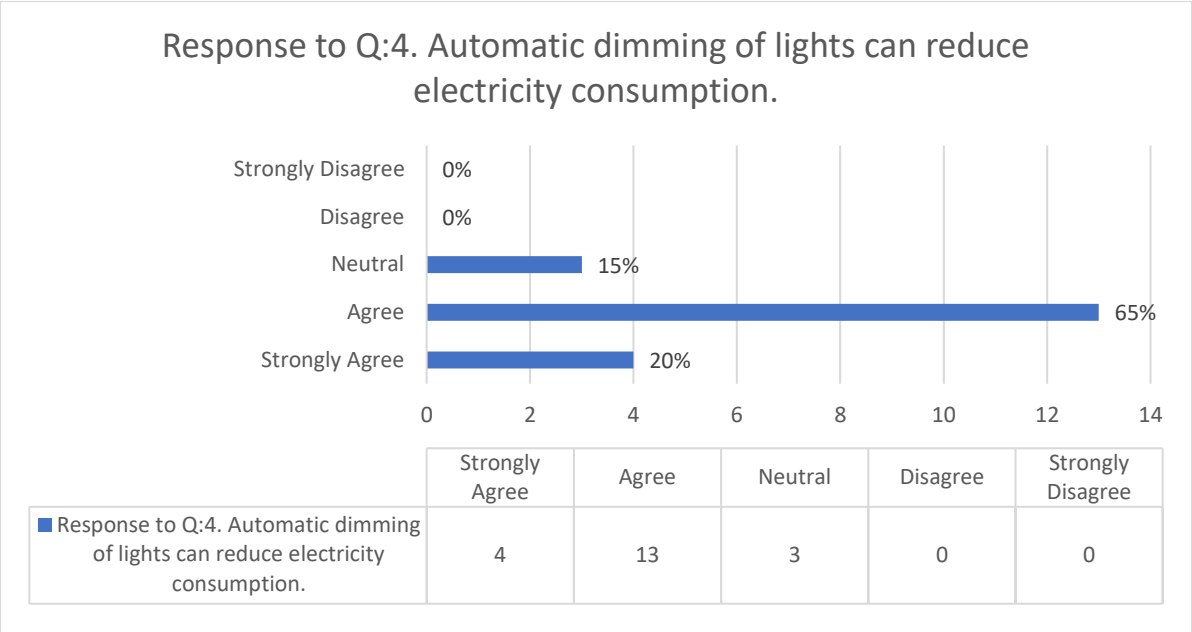

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q: 2. Smart lights can prevent unnecessary energy use by automatically switching off when a room is not occupied. | 7 | 13 | 0 | 0 | 0 |

The responses indicate that 65% (n=13) of the participants agreed and 35% (n=7) of the participants strongly agreed to the statement that smart lights help in preventing excessive energy consumption by automatically switching off the lights when no one is present in the room. While no participant disagreed, strongly disagreed or stayed neutral with the statement. Presence sensing lighting can improve energy efficiency in residential spaces by sensing the presence of a person in the space (Sith ravel et al., 2024).



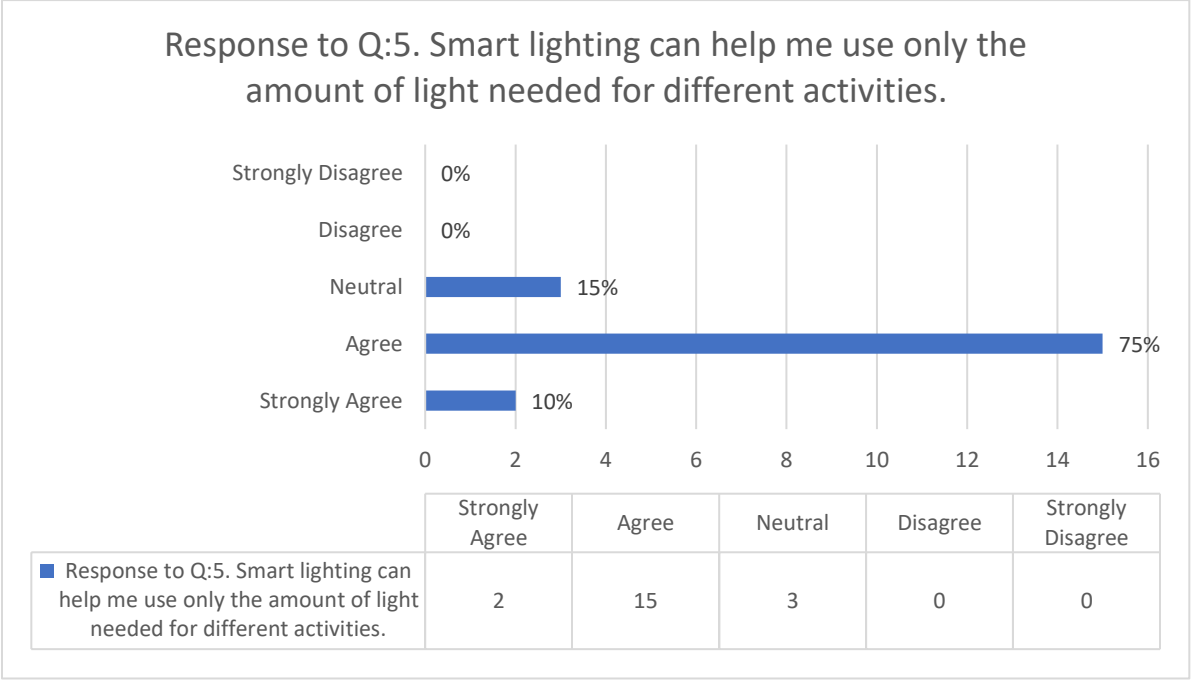

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:3. Using smart lighting according to the amount of natural daylight can help save energy. | 1 | 18 | 1 | 0 | 0 |

The results show that 90% (n=18) of the respondents agreed to the statement, 5% (n=1) strongly agreed, while 5% (n=5) stayed neutral. No one disagreed and strongly disagreed with the statement. This indicates that 95% of the participants agreed that using smart lighting in accordance with the amount of natural daylight can help in saving energy. Smart lighting can reduce the need of artificial lighting when enough daylight is present (Wang et al., 2025).



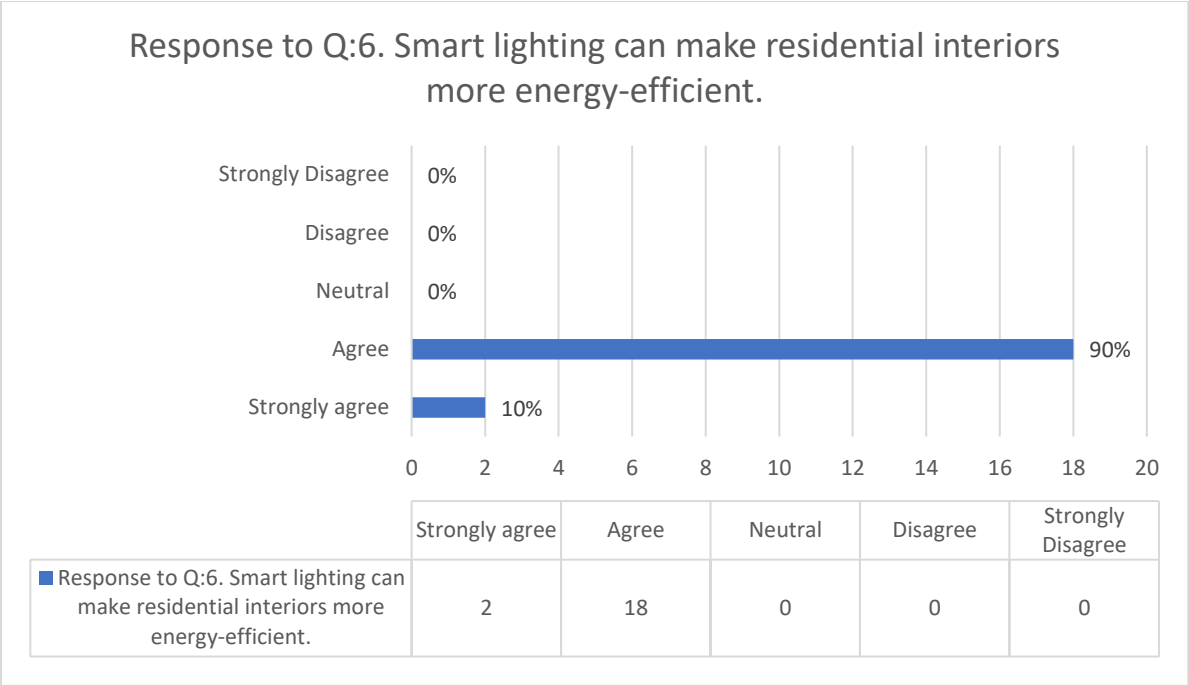

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:4. Automatic dimming of lights can reduce electricity consumption. | 4 | 13 | 3 | 0 | 0 |

Results show that 65% (n=13) of the participants agreed to the statement, while 20% (n=4) of the respondents strongly agreed with the statement, whereas 15% (n=3) stayed neutral, no one disagreed or strongly disagreed. This indicates that 85% (n=17) of the participants believe that automatic dimming of lights can help in reducing energy consumption. User centered smart lighting can adjust in accordance to occupant need and environmental conditions (Wang et al., 2025).



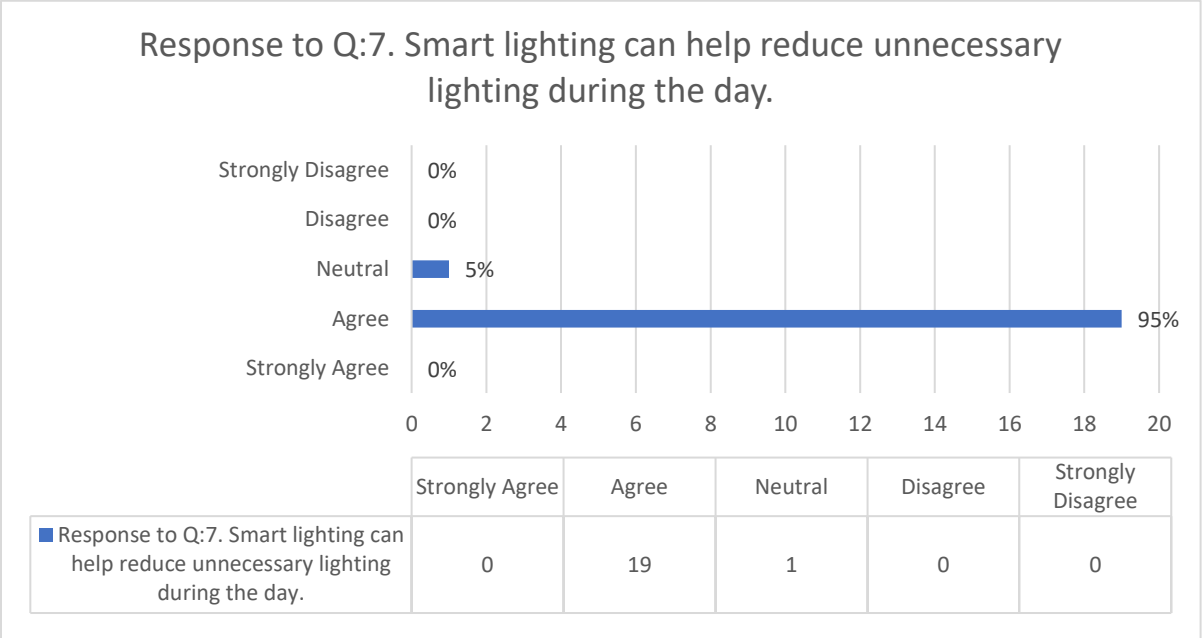

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:5. Smart lighting can help me use only the amount of light needed for different activities. | 2 | 15 | 3 | 0 | 0 |

The responses indicated that 75% (n=15) of the participants agreed with the statement and 10% (n=2) strongly agreed, while 15% (n=3) stayed neutral. Whereas no one disagreed or strongly disagreed. In total 85% of the respondents agreed that smart lighting may help them in using different amount of lighting for different activities. Smart lighting can adjust brightness according to the usage of the occupants (Wang et al., 2025).



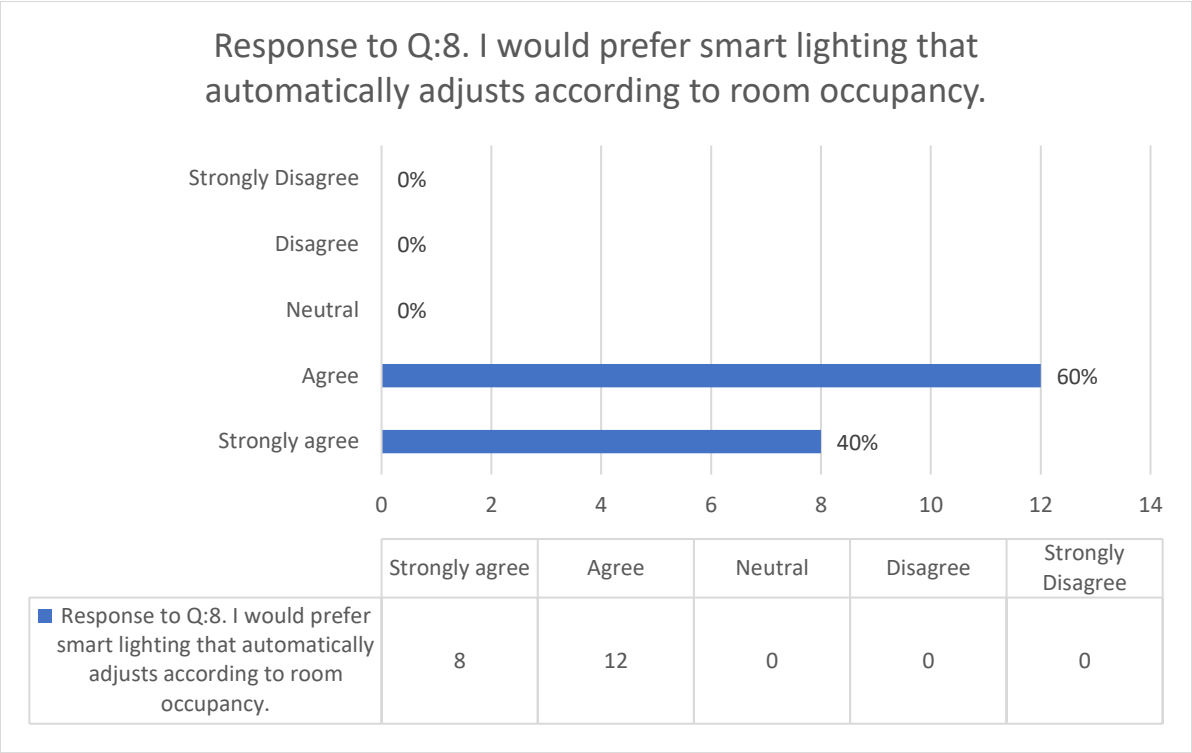

| | Strongly agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:6. Smart lighting can make residential interiors more energy-efficient. | 2 | 18 | 0 | 0 | 0 |

Results show that 90% (n=18) of the participants agreed to the statement, while 10% (n=2) of the respondents strongly agreed with the statement, whereas no participant stayed neutral, and no one disagreed or strongly disagreed. This shows that all 20 participants gave a positive response by agreeing that smart lightings can make residential spaces more energy efficient. Automated smart home technologies improve energy management and support efficiency (Qiang et al., 2023).



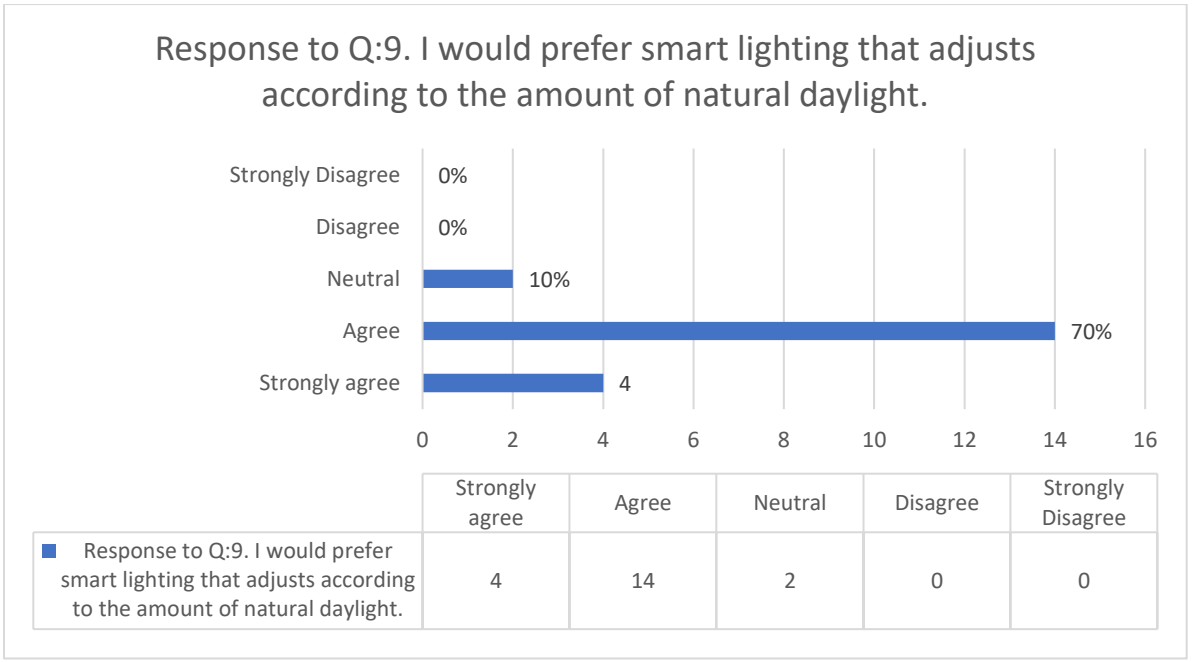

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:7. Smart lighting can help reduce unnecessary lighting during the day. | 0 | 19 | 1 | 0 | 0 |

The responses indicated that 95% (n=19) of the participants agreed with the statement, while 5% (n=1) stayed neutral. Whereas no one strongly agreed, disagreed or strongly disagreed. The results show that almost all participants agreed with the statement that smart lighting can help in reducing excessive and unnecessary lighting during day. Smart lighting systems can help in managing light by adjusting devices according to the user need (Fakhar M. Z. et al., 2023).



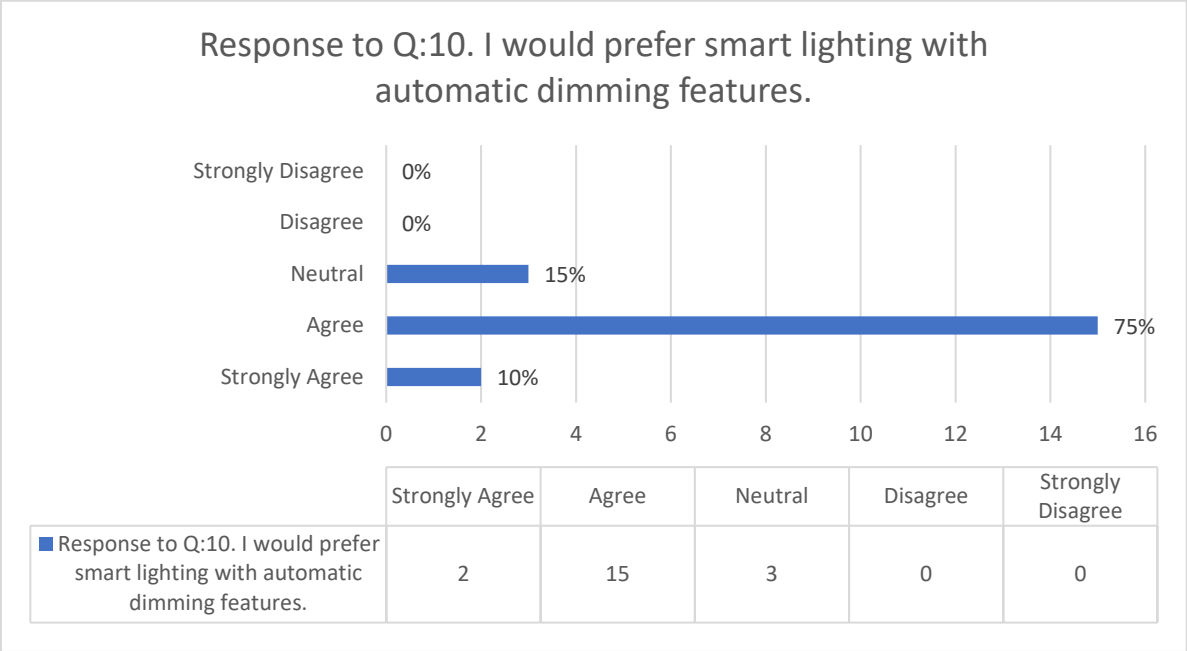

| | Strongly agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:8. I would prefer smart lighting that automatically adjusts according to room occupancy. | 8 | 12 | 0 | 0 | 0 |

The results indicates that 60% (n=12) of the respondents agreed and 40% (n=8) of the participants strongly agreed with the statement, whereas no one stayed neutral, disagreed or strongly disagreed. Therefore, all the respondents agreed and preferred to use smart lighting system that adjusts according to the room occupancy. Sensor automated lightings helps in reduce energy efficiency in residential spaces (Fakhar M. Z. et al., 2023) (Sith ravel et al., 2024).



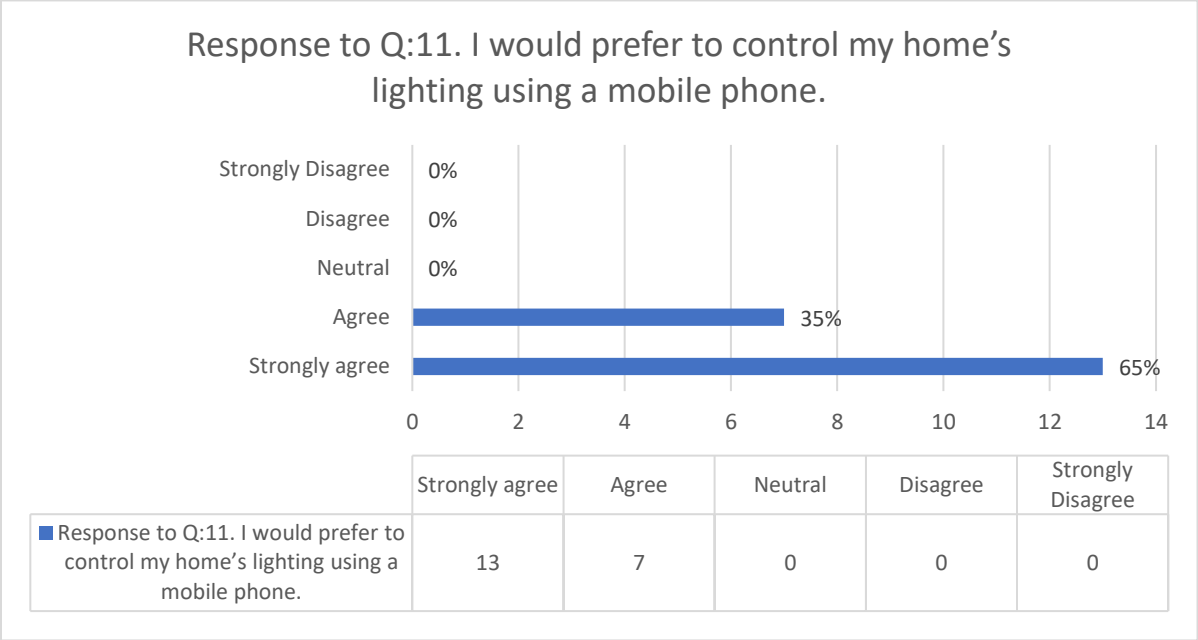

| | Strongly agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:9. I would prefer smart lighting that adjusts according to the amount of natural daylight. | 4 | 14 | 2 | 0 | 0 |

The results indicate that 70% (n=14) of the respondents agreed with the statement and 20%(n=4) strongly agreed, while 10% (n=2) stayed neutral, whereas no one disagreed or strongly disagreed with the statement. This shows that 90% of the respondents preferred smart lighting that adjusts according to the amount of natural light. IoT-based systems can be used in residential interiors for lighting control and energy efficiency (Sokienah et al., 2023).



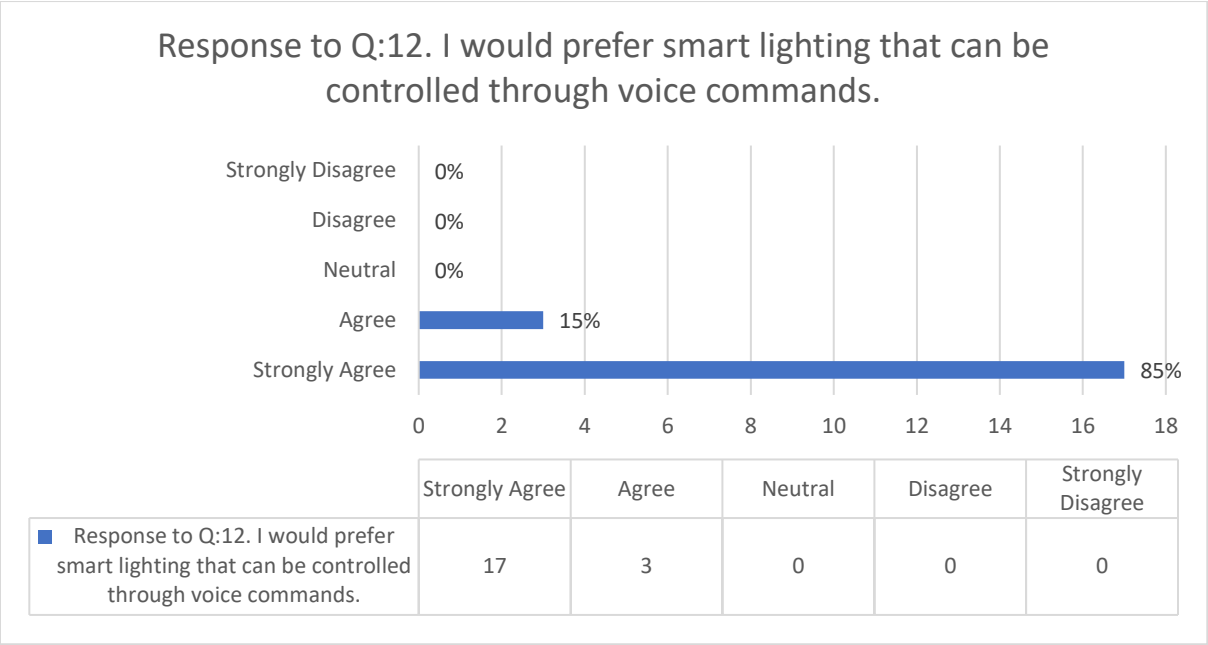

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:10. I would prefer smart lighting with automatic dimming features. | 2 | 15 | 3 | 0 | 0 |

The results indicate that 75% (n=15) of the respondents agreed with the statement and 10% (n=2) strongly agreed, while 15% (n=3) stayed neutral, whereas no one disagreed or strongly disagreed with the statement. In total 85% of the participants preferred smart lighting with automatic dimming features. Automatic dimming can help in adjusting light according to occupant preferences and surroundings (Wang et al., 2025).

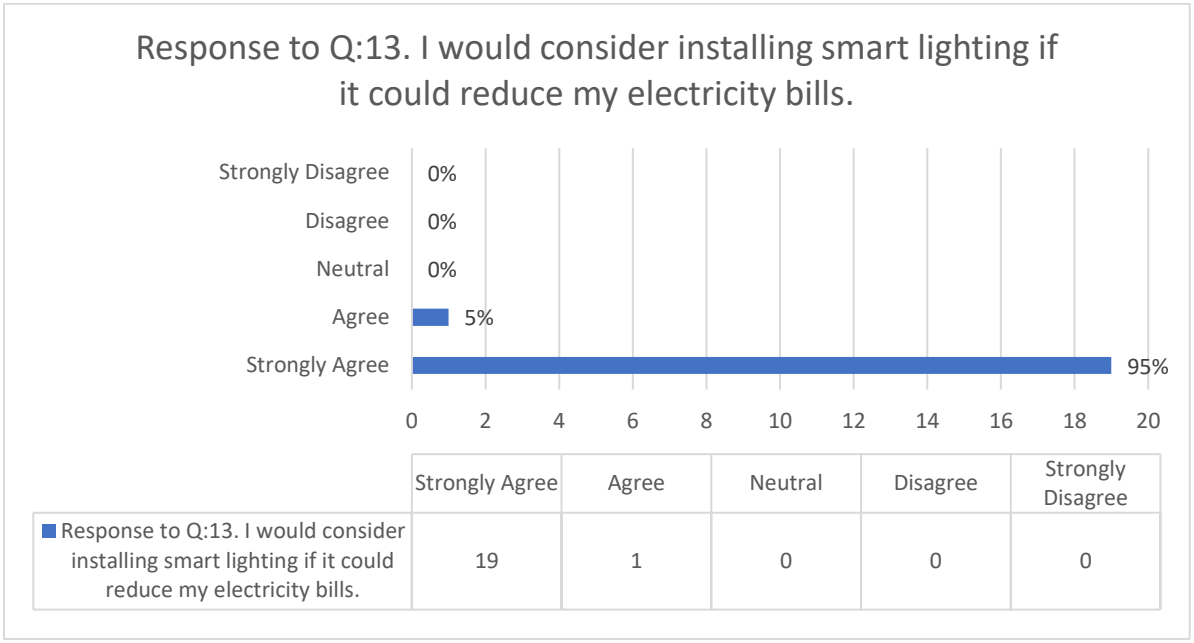



| | Strongly agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:11. I would prefer to control my home's lighting using a mobile phone. | 13 | 7 | 0 | 0 | 0 |

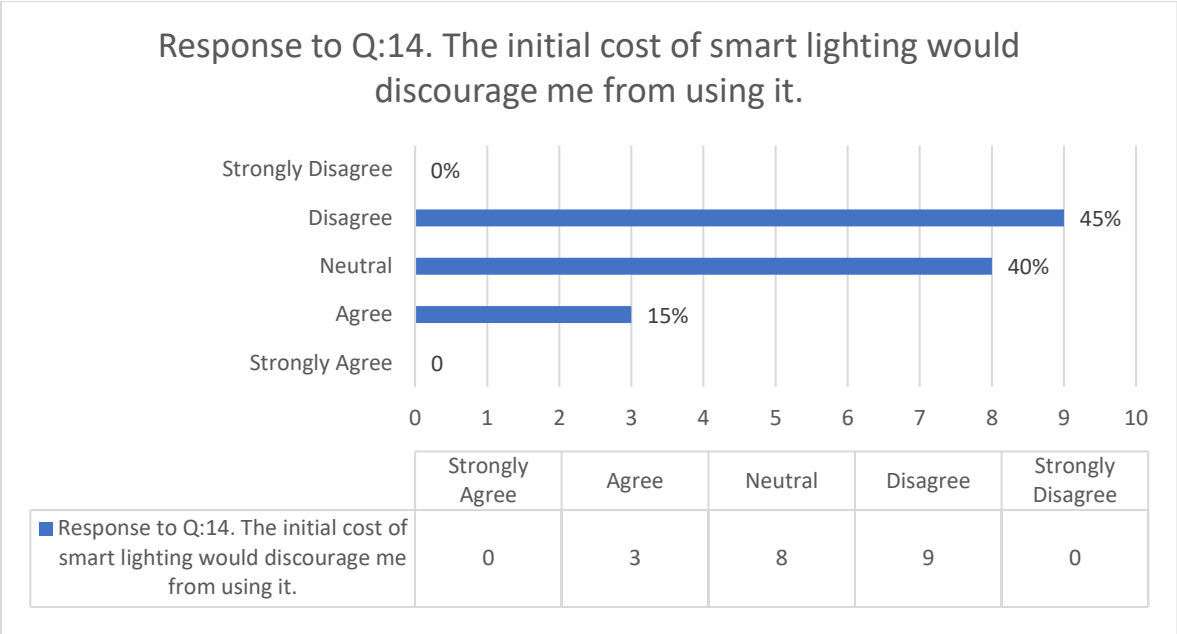
The results indicate that 65% (n=13) of the respondents agreed and 35% (n=7) of the participants strongly agreed with the statement, whereas no one stayed neutral, disagreed or strongly disagreed. This shows that all the participants preferred to use mobile phones for controlling their residential smart lighting system. Mobile phone control is significant for controlling lighting system as it allows users to adjust lighting conveniently and accordingly (Fakhar M. Z. et al., 2023).




The results show that 85% (n=17) of the respondents agreed and 15% (n=3) of the participants strongly agreed with the statement, whereas no one stayed neutral, disagreed or strongly disagreed. This indicates that all participants agreed to use smart lighting that can be controlled through voice commands. Voice control smart lighting system can help in increasing interaction between users and smart lighting technology (Huda et al., 2024).

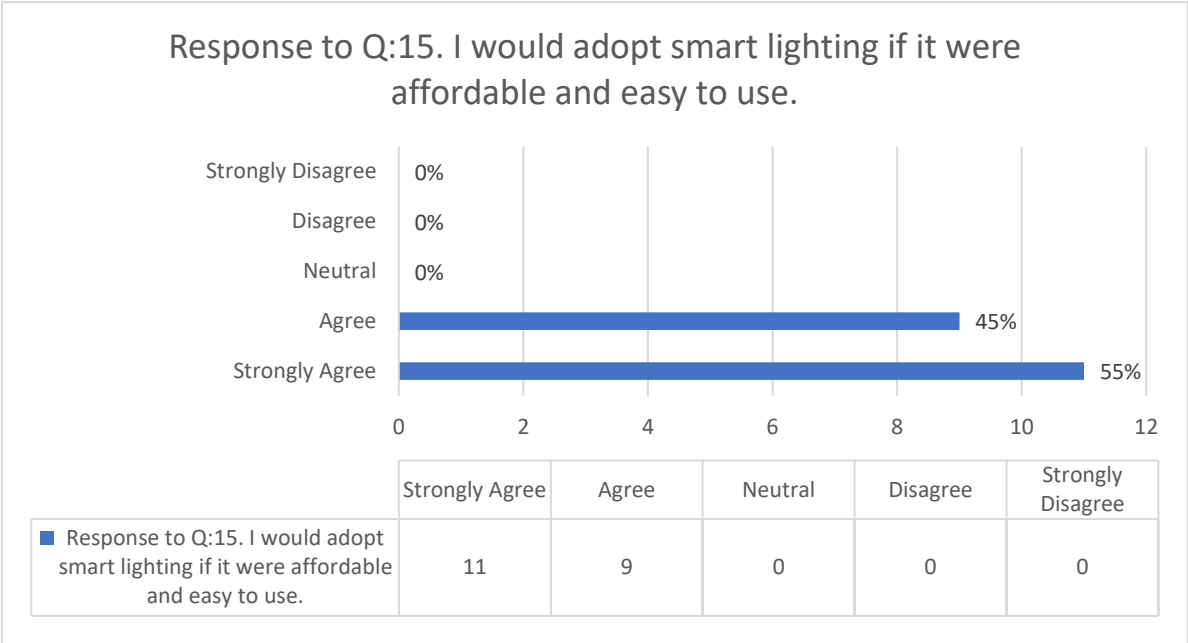



The results show that 95% (n=19) of the respondents agreed and 5% (n=1) of the participants strongly agreed with the statement, whereas no one stayed neutral, disagreed or strongly disagreed. This indicates that all participants agreed to use smart lighting that helps to reduce electricity bills effectively. IoT-based automation can help in reducing electricity costs which may influence the willingness of residents to install smart lighting system in residential spaces (Sivasankari N., 2025).



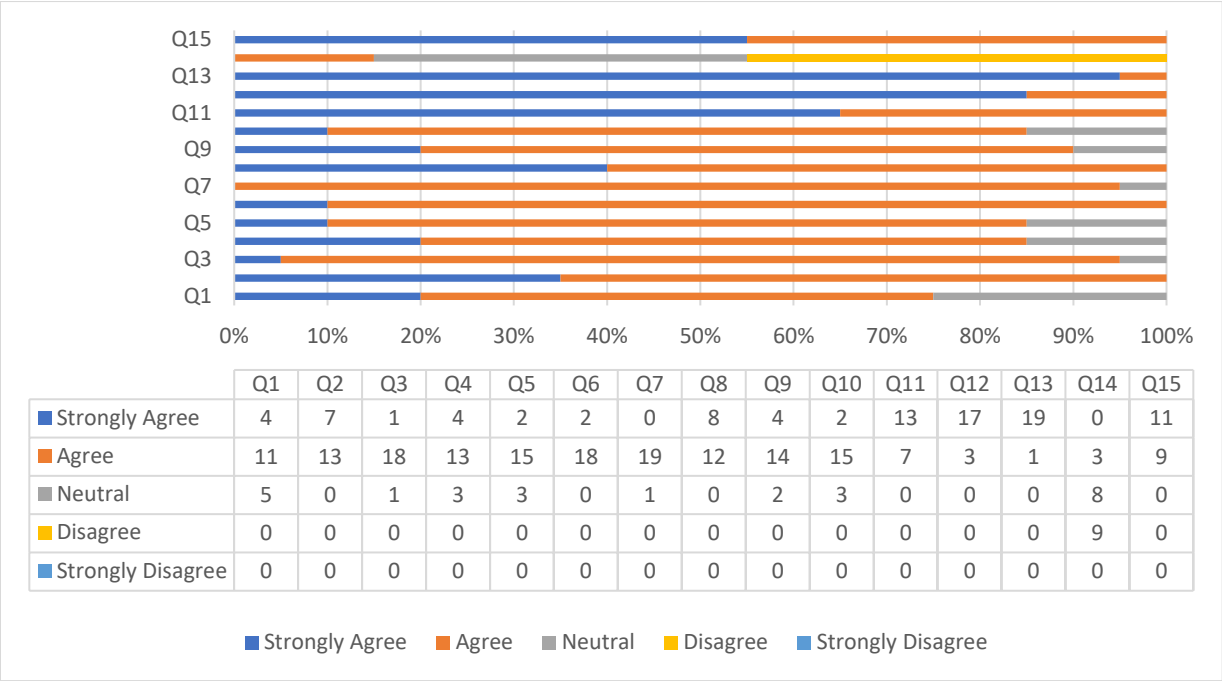

| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:14. The initial cost of smart lighting would discourage me from using it. | 0 | 3 | 8 | 9 | 0 |

The results indicate that out of 20 respondents, 45% (n=9) disagreed with the statement, 15% (n=3) agreed and 40% (n=8) remained neutral, while no one strongly agreed or strongly disagreed with the statement. Although responses were mixed but 45% did not considered the initial cost a discouragement from using smart lighting technology. Adoption of smart lighting system depends on several other contexts rather than availability (Gangakhedkar R. et al., 2024).




| | Strongly Agree | Agree | Neutral | Disagree | Strongly Disagree |
|---|---|---|---|---|---|
| Response to Q:15. I would adopt smart lighting if it were affordable and easy to use. | 11 | 9 | 0 | 0 | 0 |

The results show that 55% (n=11) of the respondents agreed and 45% (n=9) of the participants strongly agreed with the statement, whereas no one stayed neutral, disagreed or strongly disagreed. This indicates that all the participants gave positive response. The findings indicate that affordability and ease of use are significant factors considered by respondents. Affordability and accessibility are factors which influence willingness of residents to use smart home technologies (Chanda, R. C., 2024).




| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strongly Agree | 4 | 7 | 1 | 4 | 2 | 2 | 0 | 8 | 4 | 2 | 13 | 17 | 19 | 0 | 11 |
| Agree | 11 | 13 | 18 | 13 | 15 | 18 | 19 | 12 | 14 | 15 | 7 | 3 | 1 | 3 | 9 |
| Neutral | 5 | 0 | 1 | 3 | 3 | 0 | 1 | 0 | 2 | 3 | 0 | 0 | 0 | 8 | 0 |
| Disagree | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 |
| Strongly Disagree | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Summary**

The overall results indicate that respondents generally had a positive perception regarding the use of smart lighting technology in residential interiors. Through survey results it is seen that majority of the participants showed a positive perception and agreed with the statements relating to energy efficiency of smart lighting systems. In Q1 75% of the participants agreed that smart lighting could be energy efficient. In Q2 100% positive response was recorded regarding automatic switching saves energy. While in Q3 95% of participants considered smart lighting to be effective in daylight regulation. Q5 shows that 85% of respondents agreed that automatic dimming of lighting reduces energy consumption. Q6 also indicates that all participants believe that smart automation is more energy efficient. In Q7 all participants believed that smart lighting helps in reducing unnecessary consumption of lights. Q8 indicated 100% positive preference of use of smart lighting that can automatically respond to occupancy of space. Q9 shows that 90% of respondents preferred daylight responsive smart lights. Q10 indicates 85% that participants preferred automatic dimming of lights. In Q11 and Q12 user preference for mobile phone control light system and voice control light system is strongly indicated. In Q13 participants strongly agreed to prefer installing smart systems to reduce electricity costs. Q14 shows that most people were not affected by initial costs of smart lighting system, and Q15 indicates strong preference to adopt smart system if it is affordable and convenient. Overall findings suggest that residents are interested in adopting smart lighting in residential interiors.

## Conclusion

The study examined the perception of residents regarding the integration of smart lighting for energy efficient interiors. The study mainly focused on the perception of users regarding energy saving potential of smart lighting, the features the preferred, and for adoption of this technology, what factors may influence their decision. A quantitative approach was adopted and data were collected through questionnaire based on five-point likert scale.

The findings suggest that the participants generally had a positive view about the adoption of smart lighting technologies in residential interiors. Majority of the participants agreed that by using this system, consumption of energy may reduce significantly. All respondents agreed that automatic switching and presence sensor lights may help in energy efficient interior designs and can reduce electricity bills.

The results showed the strong preference of respondents regarding the use of mobile control system and voice control system for convenient controlling of lighting. Moreover, the users preferred occupancy based lighting system for comfortability and energy efficiency. Further study found that reduced electricity bills can influence users to install smart lighting technology in their residential spaces.

In conclusion the study found that residents generally showed positive response towards smart lighting for residential interiors, particularly if it provides energy saving benefits, reduce electricity costs, and offer convenient control over the lighting in interior spaces. The research contributes to understanding of smart lighting, energy efficiency and resident perception and preferences regarding integration of smart lighting in sustainable residential.

## Recommendations

- Smart lightings can be designed when room is empty then lights can switch off automatically. This may help in reduced energy consumption. Presence sensors to be installed for improving efficiency in homes (Sithravel et al., 2024).
- Daylight sensors should be installed and connect with smart lighting, to adjust artificial light according to the natural light entering the interior spaces (Sokienah et al., 2023).
- For different activities, different brightness of lighting should be used with automatic dimming systems, smart lighting can respond to the surrounding environment, making lighting more suitable for interiors (Wang et al., 2025).
- Smart lighting systems should offer smart controls, such as mobile controls and voice over controls for user convenience (Fakhar et al., 2023).
- Smart lighting should not be considered as technological feature, but should consider user preferences (Abdallah et al., 2026).

## References


1. Abdallah, S. A. (2026). The role of smart technology in achieving sustainable interior design: A comparative study of buildings. European Journal of Science and Modern Technologies, 2(2), 41–62.
2. Alongi, A., Pacileo, L., Shahrabani, M. M. N., Spūdys, P., Scoccia, R., & Mazzarella, L. (2025). Smart sensors for indoor environmental quality in residential smart buildings: A review. International Journal of Sustainable Energy, 44(1), 2578592.
3. Antonopoulos, C. A., Fuentes, T. L., McCord, K. H., Rackley, A. L. S., & Biswas, S. (2024). Regional assessment of household energy decision-making and technology adoption in the United States. Energy Policy, 185, 113940
4. Barbhuiya, S., Das, B. B., Adak, D., & Rajput, A. S. (2025). Next-generation building envelopes: Smart materials, energy efficiency and environmental impact. Next Materials, 9, 101226.
5. Chanda, R. C., Vafaei-Zadeh, A., Hanifah, H., & Ramayah, T. (2025). Modelling eco-friendly smart home appliances' adoption intention from the perspective of residents: A comparative analysis of PLS-SEM and fsQCA. Open House International, 50(2), 210–249.
6. Dong, B., Prakash, V., Feng, F., & O'Neill, Z. (2019). A review of smart building sensing system for better indoor environment control. Energy and Buildings, 199, 29–46.
7. Fakhar, M. Z., Yalcin, E., & Bilge, A. (2023). A survey of smart home energy conservation techniques. Expert Systems with Applications, 213, 118974.
8. Gangakhedkar, R., & Raman, P. (2024). Drivers and inhibitors of adoption of LED lighting by households in India: A structural equation modelling approach. International Journal of Energy Technology and Policy, 18(6), 371–392.
9. Hansen, A. R., Trotta, G., & Gram-Hanssen, K. (2024). Smart home technology adoption in Denmark: Diffusion, social differences, and energy consumption. Energy Efficiency, 17, 16.
10. Hakawati, B., Mousa, A., & Draidi, F. (2024). Smart energy management in residential buildings: The impact of knowledge and behavior. Scientific Reports, 14, 1702.
11. Huda, N. U., Ahmed, I., Adnan, M., Ali, M., & Naeem, F. (2024). Experts and intelligent systems for smart homes' transformation to sustainable smart cities: A comprehensive review. Expert Systems with Applications, 238, 122380.

12. Kallayil, A., Patadiya, J., Kandasubramanian, B., Adamtsevich, A., Kchaou, M., & Aldawood, F. K. (2025). Adaptive smart materials in architecture: Enhancing durability and sustainability in modern construction. ACS Omega, 10(22), 22305–22322.

13. Metwally, E. A., Ismail, M. R., & Farid, A. A. (2024). Development of an IoT occupant-centric metrics: A systematic literature review. Results in Engineering, 23, 102614.

14. Moadab, N. H., Olsson, T., Fischl, G., & Aries, M. (2021). Smart versus conventional lighting in apartments: Electric lighting energy consumption simulation for three different households. Energy and Buildings, 244, 111009.

15. Ning, C., Shen, D., Dong, Y., Wang, Y., & Duan, P. (2024). Research on fine-grained modeling and optimal control used for occupant-centric smart lighting systems. SSRN.

16. Qiang, G., Tang, S., Hao, J., Di Sarno, L., Wu, G., & Ren, S. (2023). Building automation systems for energy and comfort management in green buildings: A critical review and future directions. Renewable and Sustainable Energy Reviews, 179, 113301.

17. Sithravel, R., Olsson, T., & Aries, M. (2024). Optimizing presence sensing lighting for energy efficiency and user behavioral needs in small Swedish homes. LEUKOS, 20(1), 107–125.

18. Sokienah, Y. (2023). Exploring the integration of IoT systems in interior design and the built environment: A systematic review. Heliyon, 9(12), e22869.

19. Soheilian, M., Fischl, G., & Aries, M. (2021). Smart lighting application for energy saving and user well-being in the residential environment. Sustainability, 13(11), 6198.

20. Soleimanijavid, A., Konstantzos, I., & Liu, X. (2024). Challenges and opportunities of occupant-centric building controls in real-world implementation: A critical review. Energy and Buildings, 308, 113958.

21. Sivasankari, N., & Rathika, P. (2025). IoT driven building automation systems: A review on energy efficiency, occupant comfort, and sustainability. Journal of Building Engineering, 104, 112347.

22. Sobczyk, M., Wiesenhütter, S., Noennig, J. R., & Wallmersperger, T. (2022). Smart materials in architecture for actuator and sensor applications: A review. Journal of Intelligent Material Systems and Structures, 33(3), 379–399.

23. Tyagi, P., & Kanyal, P. (2025). Designing with smart materials: Towards sustainable and adaptive built environments. In Engineering research: Perspectives on recent advances (Vol. 8, pp. 19–33). Book Publishing International.

24. Wang, Y., Zhang, X., & Chen, H. (2025). From needs to control: A review of indicators and sensing technologies for occupant-centric smart lighting systems. Energy and Buildings, 339, 115740.

25. Yuan, Y., Song, C., Gao, L., Zeng, K., & Chen, Y. (2024). A review of current research on occupant-centric control for improving comfort and energy efficiency. Building Simulation, 17, 1675–1692.