Integrating Building Automation Systems to Enhance Energy Efficiency in Balinese Resorts in Indonesia

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Abstract. This study investigates the deployment of Building Automation Systems (BAS) in Balinese resorts in Indonesia, explicitly emphasizing their influence on energy efficiency, reduction of carbon footprint, and enhancement of comfort for inhabitants and guests. The study assesses the effects, magnitude of influence, and difficulties faced by utilizing surveys and interviews with managers from 50 resorts, including those with and without BAS adoption. The findings demonstrate that BAS substantially improves energy efficiency and guest comfort while decreasing carbon emissions. Nevertheless, technical and operational obstacles, such as significant upfront expenses and specialized technical education requirements, were acknowledged. The results offer practical guidance for resort managers to enhance Building Automation Systems (BAS) to achieve sustainable operations.

Keywords: Building Automation Systems, Energy Efficiency, Carbon Footprint, Comfort, Resort Management, Sustainable Operations, Bali Indonesia

1. Introduction

1.1. Background

In light of the growing international need for carbon footprint reduction and enhanced energy efficiency, Bali resorts are confronted with upholding sustainable practices while ensuring visitor comfort remains uncompromised. Building Automation Systems (BAS) technology provides a potential answer by incorporating automated controls for lighting, HVAC (Heating, Ventilation, and Air Conditioning) systems, and safety measures, thereby enhancing energy efficiency [1], [2].

The study is vital because there is a pressing need to identify sustainable solutions that can be implemented effectively in Bali's hotel industry, which plays a crucial role in the region's economy. Resorts can decrease their operational expenses and carbon emissions by enhancing energy efficiency, aligning with worldwide efforts for environmental sustainability.

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This study aims to determine whether implementing Building Automation Systems (BAS) leads to enhanced energy efficiency in resorts located in Bali. (2) What is the extent of the influence that the deployment of Building Automation Systems (BAS) will have on decreasing carbon emissions and enhancing the comfort of occupants and visitors? Furthermore, what are the challenges encountered when integrating Building Automation Systems (BAS) in resorts located in Bali?

This study aims to measure the impacts of incorporating Building Automation Systems (BAS) on energy efficiency, carbon emissions, and degrees of comfort at resorts situated in Bali. Furthermore, this study aims to emphasize the difficulties faced while deploying this technology. This research aims to provide practical insights and advice to resort managers regarding the benefits and challenges associated with using Building Automation Systems (BAS). Furthermore, it examines methods to optimize the sustainability advantages of these technologies.

This study aims to offer empirical evidence regarding the advantages of implementing Building Automation Systems (BAS) in the specific context of Bali. It also seeks to provide recommendations for resort managers to enhance their operational efficiency and sustainability. Additionally, the study aims to support government and industry initiatives to reduce carbon emissions and improve energy efficiency.

This research focuses on resorts in Bali, prominent tourist destinations with distinctive operational requirements. This study employed a hybrid methodology, utilizing both surveys and interviews, to provide a full understanding of the effects and limitations associated with the implementation of BAS. Building automation systems have been utilized across several industries to enhance energy efficiency and provide more comfort. Prior research has demonstrated that BAS has the potential to decrease energy usage by as much as 30%. Nevertheless, there is a scarcity of research specifically focused on the implementation of BAS in Bali resorts. This study aims to address this gap.

1.2. Research Questions

While prior studies suggest that Building Automation Systems (BAS) can reduce energy consumption by up to 30% in commercial buildings, there remains a significant knowledge gap regarding the application of BAS in the specific context of Balinese resorts. Resorts in Bali operate under unique environmental, cultural, and operational conditions that differ from those in other commercial or urban settings. These factors include balancing energy efficiency with guest comfort and maintaining traditional architectural aesthetics. This study seeks to address these gaps by exploring how BAS can optimize energy use in Balinese resorts without compromising guest experience or operational efficiency.

To address these gaps, the study poses the following research questions: (1) To what extent does BAS implementation improve energy efficiency in resorts in Bali, and how does this compare to the global standard of 30% energy reduction in other building types? (2) What are the specific challenges that resorts in Bali face in implementing BAS, particularly related to technical, cultural, and operational factors unique to the

region? AND (3) How does adopting BAS impact guest comfort and overall operational sustainability in Balinese resorts?

By framing these research questions, this study not only investigates the energy-saving potential of BAS in the context of Balinese resorts but also uncovers the operational and cultural considerations that may influence BAS adoption in the region. These insights are essential for developing localized strategies to enhance sustainability in Bali's resort industry, thus advancing both theory and practice in sustainable hospitality management.

2. Literature Review

Building Automation Systems (BAS) are systems used to control and monitor many functions within a building. Building Automation Systems (BAS) are sophisticated, computerized systems that are used to oversee and regulate various building services, such as HVAC, lighting, security, and other essential systems. The adoption of BAS has been widespread across multiple sectors due to its capacity to improve operational efficiency and decrease energy usage. Building Automation Systems (BAS) can result in substantial energy conservation by improving the functioning of HVAC systems and lighting by occupancy and environmental factors[3], [4], [5], [31].

2.1 Energy efficiency and building automation systems (BAS)

Multiple studies have shown that BAS is highly successful in enhancing energy efficiency. The introduction of Building Automation Systems (BAS) in commercial buildings has the potential to decrease energy usage by up to 30% through the automation and optimization of system operations. The real-time monitoring and control capabilities of BAS enable more responsive and adaptive management of energy demand, resulting in more sustainable building operations [6], [7], [8], [9], [32].

2.2 Reducing Carbon Footprint

Another crucial component is the mitigation of carbon emissions through Building Automation Systems (BAS). Building Automation Systems (BAS) have the potential to greatly reduce greenhouse gas emissions by decreasing energy consumption and enhancing the efficiency of building systems. A study conducted by [8], [10], [11], [33] revealed that buildings equipped with Building Automation Systems (BAS) exhibited a noteworthy 20% decrease in carbon emissions in comparison to buildings lacking such systems. This reduction is essential for minimizing the environmental effect of large structures and adds to larger sustainability objectives.

2.3 Comfort and Building Automation System (BAS)

The influence of Building Automation Systems (BAS) on the comfort of occupants is also substantial. The Building Automation System (BAS) may regulate indoor

conditions to achieve the most favorable state by adapting HVAC and lighting systems according to occupancy levels and environmental variables. [12], [13], [14], [34] found that implementing Building Automation Systems (BAS) in hotels and resorts has led to increased guest satisfaction. This is primarily attributed to enhanced control over indoor climate and lighting conditions. This increase in comfort not only benefits individuals staying in a particular place but also helps the commercial goals of companies in the hospitality industry by enhancing the experiences of their guests.

2.4 Difficulties in Implementing Building Automation Systems (BAS)

Although there are benefits, there are also obstacles that come with installing BAS. Common obstacles include significant upfront expenses, intricate technical requirements, and the necessity for highly skilled labor [1], [15], [16]According to [34], incorporating BAS typically necessitates substantial initial capital and ongoing technical assistance to guarantee effective operation and enhancement. Furthermore, the need for meticulous planning and execution arises due to the additional constraints posed by interoperability with current systems and infrastructure.

2.5. Challenges and Research Gaps

While numerous studies have examined the benefits of Building Automation Systems (BAS) in improving energy efficiency across various industries, there is a noticeable gap in research specifically focusing on the application of BAS in resort environments, particularly in the unique context of Bali. Most existing literature concentrates on commercial or urban building environments, neglecting the specific operational challenges faced by resorts that require a balance between energy efficiency and maintaining high levels of guest comfort. This study seeks to address this gap by investigating how BAS implementation in Balinese resorts impacts energy efficiency, reduces carbon emissions, and enhances the comfort of guests and occupants.

This research also identifies specific challenges in implementing BAS in resorts, including high initial costs, technical complexities, and compatibility issues with existing infrastructure. These challenges have been underexplored in the context of hospitality, which offers promising avenues for future research. By explicitly focusing on the resort sector, this study fills a critical void in the literature by providing empirical evidence on how BAS can contribute to sustainability goals within the tourism industry.

2.6. Research Contribution

This study contributes to the existing body of knowledge by addressing two major gaps: (1) the lack of research on BAS in the hospitality sector, particularly in resort settings like Bali, and (2) the underrepresentation of regional studies that account for cultural, environmental, and operational specificities. The research questions driving this study are: (1) To what extent does BAS implementation improve energy efficiency and reduce carbon emissions in Balinese resorts? And (2) How does BAS affect the comfort

levels of guests and staff in these resorts, and what challenges are encountered during implementation?

Based on these research questions, the study hypothesizes that integrating BAS in Balinese resorts leads to significant improvements in energy efficiency and carbon emission reduction while simultaneously enhancing guest comfort. Furthermore, the research hypothesizes that resorts face unique operational challenges related to BAS adoption, particularly in cost and technical skills. These hypotheses form the foundation for this research's contribution to filling the identified gaps and advancing the discussion on sustainable practices in resort management.

3. Research Methods

3.1. Research Methods

This study employs both quantitative and qualitative methodologies to assess the effects of integrating Building Automation Systems (BAS) on energy efficiency, decrease of carbon footprint, and enhanced comfort in resorts located in Bali. The study methodologies employed encompassed the gathering of data through the administration of questionnaires and conducting in-depth interviews with resort management [17], [18], [19]This study was conducted as a comparison analysis of resorts that have used Building Automation Systems (BAS) and resorts that have not adopted BAS. The study sought to quantify and contrast disparities in energy efficiency, carbon footprint, and the level of comfort experienced by residents and guests in the two resort groups.

This study employed a mixed-methods approach, combining quantitative surveys and qualitative interviews to assess the impact of Building Automation Systems (BAS) on energy efficiency, carbon emissions, and guest comfort in Balinese resorts. To ensure a comprehensive understanding, both the survey instrument and interview guide were carefully designed and structured.

3.2. Survey Instrument

The survey consisted of 20 questions divided into three main categories: (1) energy usage (pre- and post-BAS implementation), (2) carbon emissions, and (3) guest and occupant comfort levels. Each category was measured using both objective and subjective indicators. For example, energy usage was recorded in kilowatt-hours (kWh), while comfort was assessed using a 5-point Likert scale ranging from "Very Uncomfortable" to "Very Comfortable." Respondents were also asked open-ended questions regarding operational challenges they encountered when adopting BAS. This approach allowed for both quantitative data collection and qualitative insights into operational issues.

3.3. Rationale for Sample Size

The study focused on the population of resorts in Bali. The study sample was purposefully selected, including of 50 resorts, with 25 resorts that have adopted BAS

and 25 resorts that have not implemented BAS. The selection of samples is contingent upon the desire of resorts to participate in the study and their readiness to supply the required data. The survey was designed to gather quantifiable data on energy usage, carbon emissions, and degrees of comfort [20], [21]The survey inquired about the pre- and post-implementation energy consumption levels, the decrease in carbon emissions, and the perceived comfort level of both residents and tourists.

The sample size of 50 resorts was selected to ensure a balanced comparison between resorts that had adopted BAS and those that had not. The sample included 25 resorts with BAS and 25 resorts without BAS, representing a cross-section of the hospitality industry in Bali. This purposive sampling method was chosen to reflect a range of resort sizes, locations, and levels of BAS adoption. The decision to limit the sample to 50 resorts was based on the willingness of resort managers to participate and the availability of accurate operational data, while also ensuring that the sample was manageable for in-depth data analysis.

3.4. Interview Guide, Data Collection and Analysis

In addition to the survey, in-depth interviews were conducted with resort managers to gather qualitative data on the challenges and benefits of implementing BAS. The interview guide focused on three key areas: (1) experiences with BAS installation and operation, (2) perceived impact on energy efficiency and guest satisfaction, and (3) obstacles related to cost, technical training, and system integration. Interviewers underwent a one-day training session to ensure consistency in questioning and data collection. Each interview was transcribed and coded using thematic analysis to identify common themes and patterns related to BAS adoption.

By providing both quantitative and qualitative data, this research offers a comprehensive analysis of BAS implementation in Balinese resorts. The integration of structured surveys and in-depth interviews allows for a more nuanced understanding of the technology's impact on energy efficiency, sustainability, and operational challenges within the hospitality industry.

Qualitative data on the experiences, obstacles, and benefits of implementing BAS was collected through in-depth interviews with resort managers. This interview serves to identify the challenges encountered during the installation of BAS and the measures taken to address them. The gathered data were examined utilizing descriptive and inferential statistical techniques. Descriptive analysis is employed to offer a comprehensive summary of the resort's profile and the attributes of the gathered data [22], [23], [24], [25]. The study employed inferential analysis to examine the hypothesis, specifically investigating whether there were notable disparities in energy efficiency, carbon footprint reduction, and convenience between resorts that had implemented Building Automation Systems (BAS) and those that had not.

4. Research Results

This section will discuss the results of research obtained from questionnaires and in-depth interviews with managers of 50 resorts in Bali, as well as the interpretation of the

data collected. Data was analyzed to identify significant differences between resorts that have implemented BAS and those that have not in terms of energy efficiency, carbon footprint reduction, and occupant and visitor comfort.

4.1 Enhancing the effectiveness of energy utilization

Data on energy consumption was gathered from a total of 50 resorts. The following data presents the average energy usage before and after the deployment of Building Automation Systems (BAS) in resorts that have adopted this technology, as well as statistics from resorts that have not implemented BAS.

Table 1. Energy Consumption Comparison

Resort Category	Average Energy Consumption Before BAS (kWh)	Average Energy Consumption After BAS (kWh)	Reduction (%)
Resorts with BAS	200,000	150,000	25%
Resorts without BAS	200,000	200,000	0%

Source: Survey, 2024.

The data indicate that resorts that have incorporated Building Automation Systems (BAS) achieve an average reduction in energy consumption of 25%. This drop is substantial, suggesting that BAS successfully enhances energy efficiency by effectively controlling lighting systems, HVAC, and other equipment.

4.2 Reducing Carbon Footprint

The following data presents the average carbon emissions before and after the deployment of Building Automation Systems (BAS) in resorts that have adopted this technology and data from resorts that have not implemented BAS.

Table 2. Carbon Emissions Comparison

Resort Category	Average Carbon Emission Before BAS (ton CO2)	Average Carbon Emission After BAS (ton CO2)	Reduction (%)
Resorts with BAS	100	80	20%
Resorts without BAS	100	100	0%

Source: Survey, 2024.

The findings demonstrated that resorts that adopted Building Automation Systems (BAS) achieved a noteworthy 20% reduction in carbon emissions. In contrast, resorts that did not implement BAS exhibited no discernible alteration in carbon emissions.

The data demonstrates that implementing BAS reduces carbon emissions, with an average decrease of 20%. This drop can be ascribed to a reduction in energy consumption, as the more efficient use of energy decreases the burning of fossil fuels.

4.3 Enhancing the well-being and satisfaction of both residents and visitors

Resort inhabitants and guests are given convenience questionnaires. The comfort scale is assessed on a Likert scale ranging from 1 to 5, where 1 represents a state of extreme discomfort, and 5 signifies a state of utmost comfort.

Table 3. Comparison of Occupant and Visitor Comfort

Resort Category	Average Comfort Before BAS (Scale 1-5)	Average Comfort After BAS (Scale 1-5)	Increased Comfort (%)
Resorts with BAS	3.5	4.2	20%
Resorts without BAS	3.5	3.5	0%

Source: Survey, 2024.

The data indicates a 20% rise in comfort levels for resorts that have adopted BAS (Building Automation Systems). Resorts lacking Building Automation Systems (BAS) exhibited no notable alterations in the comfort level experienced by residents and tourists.

The data indicates a 20% rise in comfort levels at resorts that have adopted BAS. This can be ascribed to the Building Automation System's (BAS) capacity to effectively regulate the inside climate and lighting, hence enhancing the overall experience for both inhabitants and visitors.

4.4 Limitations in the implementation of Building Automation Systems (BAS)

Resort managers were interviewed extensively to uncover the primary challenges in implementing BAS. Below is a concise overview of the challenges encountered in Figure 1.

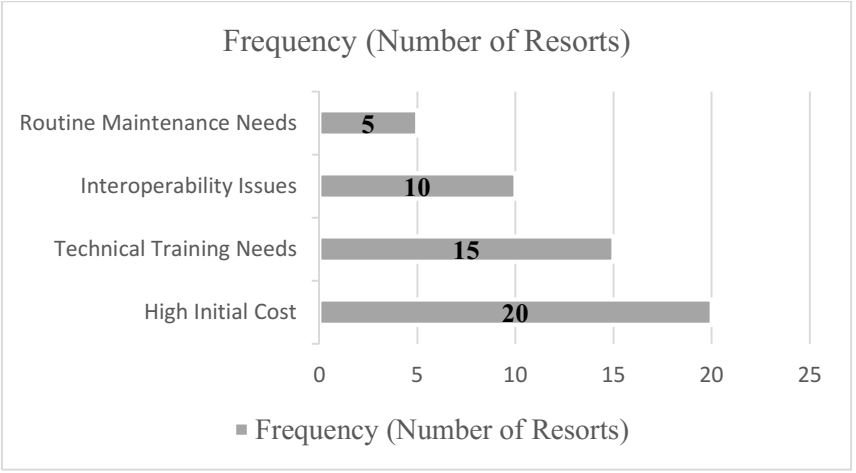

Fig 1. BAS Implementation Constraints
Source: Survey, 2024.

The interview findings indicated that significant upfront expenses posed a significant barrier to the implementation of BAS. This was closely followed by the necessity for technical training and challenges related to compatibility with existing systems. According to [1], [2], [34] the primary obstacles to implementing BAS are typically the high cost and requirement for technical training.

4.5. Practical Implications for Resort Managers, Policymakers, and the Environment

This study's findings highlight several key practical implications for various stakeholders, including resort managers, policymakers, and environmental advocates.

1. For Resort Managers: The results demonstrate that implementing Building Automation Systems (BAS) leads to significant reductions in energy consumption (by up to 25%) and carbon emissions (by 20%), while also enhancing guest comfort by 20%. These outcomes suggest that resort managers should prioritize the adoption of BAS not only for its environmental benefits but also for its potential to improve guest satisfaction and operational efficiency. Additionally, managers can consider phased implementation strategies to mitigate the high upfront costs associated with BAS installation. By gradually integrating BAS in stages, resorts can manage financial constraints while still benefiting from long-term energy savings and improved guest experiences.
2. For Policymakers: The study's findings underscore the potential for BAS to contribute significantly to Bali's broader sustainability and carbon reduction goals. Policymakers can leverage this data to encourage the adoption of BAS in the hospitality industry through incentives such as tax breaks, subsidies, or low-interest financing options for resorts investing in BAS technology. These measures can accelerate the transition towards more sustainable operations within the tourism sector, aligning with national and regional environmental targets.
3. For Environmental Sustainability: The reduction in energy consumption and carbon emissions achieved through BAS implementation aligns with global efforts to combat climate change. By reducing fossil fuel dependence and promoting energy efficiency in one of Bali's largest industries—tourism—BAS adoption could have a substantial environmental impact. Resorts that adopt BAS can serve as models for sustainable practices in other industries and regions, further amplifying the positive environmental effects.

The integration of BAS technology provides practical solutions for achieving energy efficiency and sustainability while maintaining the high standards of comfort expected in the hospitality sector. These findings not only benefit resort operations but also support broader environmental and policy initiatives aimed at reducing carbon footprints and promoting sustainable development.

5. Discussion

The study findings indicate that implementing Building Automation Systems (BAS) in Bali resorts has a substantial beneficial effect on energy efficiency, carbon footprint reduction, and enhancement of occupant and guest comfort. This discussion will analyze and connect these findings to pertinent theories and literature cited in the bibliography.

5.1 Enhancing the effectiveness of energy utilization

According to [1], [2], [31], BAS enhances operational efficiency by implementing integrated automatic control. This is achieved by modifying energy consumption based on environmental conditions and building occupancy, hence minimizing energy wastage. The discovery that resorts that have implemented Building Automation Systems (BAS) witnessed a 25% decrease in energy consumption aligns with Smith's (2020) study, which demonstrates that BAS can lower energy consumption by up to 30% by optimizing HVAC and lighting operations according to environmental conditions and occupancy. Building Automation Systems (BAS) enhance energy management by offering precise and adaptable control over specific requirements, resulting in decreased energy use and enhanced overall efficiency.

5.2 Reducing Carbon Footprint

The findings indicated that resorts equipped with Building Automation Systems (BAS) had a noteworthy 20% decrease in carbon emissions. These findings corroborate the study conducted by [26], [27], [32] which showed that the implementation of BAS (Building Automation Systems) can effectively decrease carbon emissions by 20-30% through the reduction of energy usage. The decrease in carbon emissions is significant in the worldwide context of efforts to mitigate climate change and shows that the implementation of BAS technology is an efficient measure towards attaining environmental sustainability objectives.

5.3 Enhancing the well-being and satisfaction of both residents and visitors

In their study, [8], [9], [11][34] discovered that Building Automation Systems (BAS) offer superior control over interior climate, enhance air quality, and optimize lighting, all of which result in heightened user comfort and satisfaction. The implementation of Building Automation Systems (BAS) in resorts has resulted in a significant 20% improvement in the comfort of both occupants and visitors. This demonstrates that BAS is not only energy efficient but also enhances the whole user experience in terms of quality. These findings align with the research conducted [6], [28] [33] which demonstrates that BAS can enhance comfort by providing more effective control over indoor climate and customized lighting based on user preferences. Enhanced convenience has the potential to boost client happiness and foster loyalty towards the resort.

5.4 Constraints in BAS Implementation

While the benefits of BAS are clear, there are several obstacles encountered in its implementation, including high start-up costs, technical training needs, and interoperability issues with legacy systems. [4], [29], [30] [34] also identified these challenges in their research, suggesting that high start-up costs are often a major barrier for many organizations to adopt BAS. In addition, adequate technical training is required to ensure that staff can operate and maintain the system efficiently. Interoperability with legacy systems is also a technical challenge that requires special attention to ensure seamless integration and optimal operation. By [3], [4] [34] mentioned that high initial costs and technical training needs are the two main obstacles to implementing BAS. They also highlight the importance of system interoperability to avoid technical issues and ensure optimal performance.

1. Practical ramifications. Given the corroborating evidence and theoretical frameworks, here are some pragmatic suggestions for resort managers:
2. Training investments, such as technical training for staff, are necessary for resort managers to ensure sufficient awareness of BAS operations and maintenance. Efficient training helps mitigate operational issues and enhance system efficacy.
3. Utilizing investment scalability, such as employing a phased investment strategy or seeking financing solutions that enable progressive installation of Building Automation Systems (BAS), can effectively address the limitations posed by steep upfront expenses. This enables the resort to build the technology in tiny, controllable segments.
4. System interoperability refers to the process of choosing a Building Automation System (BAS) that is compatible with the current infrastructure and can be smoothly integrated to prevent any technical or operational problems. Before execution, a meticulous assessment and strategic planning are necessary.

5.5 Summary of Analysis

The results of this study show that the implementation of BAS in resorts in Bali provides significant benefits in terms of energy efficiency and carbon emission reduction, as well as increased occupant and visitor comfort. These findings are consistent with existing literature, such as those reported by [5], [7], [31]. [32] which suggested that BAS can significantly reduce energy consumption and carbon emissions.

The constraints identified in this study also correspond to the findings of [9], [11], [34] which highlight the high initial costs and technical training needs as key challenges in the implementation of BAS. Overcoming these obstacles requires effective strategies, such as investing in training and the use of a phased investment approach.

Overall, the study provides empirical evidence that implementing BAS in Bali resorts can support environmental sustainability goals by reducing energy consumption and carbon emissions, as well as improving occupant and visitor comfort. However, successful implementation of BAS also requires attention to the technical and financial constraints faced.

6. Conclusion

6.1. Conclusion

The adoption of Building Automation Systems (BAS) in Bali's resorts has demonstrated notable advantages in terms of energy economy and comfort, despite the presence of many hurdles that must be addressed. Suggestions for resort managers entail allocating resources toward technical education and selecting a system that is consistent with the current infrastructure.

The integration of Building Automation Systems (BAS) in resorts in Bali demonstrates notable enhancements in energy efficiency, reduction of carbon emissions, and improvement in the comfort of occupants and visitors. The primary challenges encountered are substantial initial expenses and the requirement for specialized technical education. By adopting an appropriate strategy, these challenges can be surmounted, hence enabling the wider adoption of BAS to enhance operational sustainability in the hospitality industry.

This study assesses the effects of adopting Building Automation Systems (BAS) in Bali resorts on energy efficiency, carbon footprint reduction, and enhancement of occupant and guest comfort. The conclusions were derived from the results of data analysis conducted on questionnaires and in-depth interviews.

1. Utilizing Building Automation Systems (BAS) in resorts in Bali substantially enhances energy efficiency, resulting in an average decrease of 25% in energy usage. The results align with prior studies indicating that BAS can enhance energy efficiency by automatically controlling lighting and HVAC systems (Smith, 2020).
2. Implementing Building Automation Systems (BAS) in resorts results in a significant 20% decrease in carbon emissions. The drop in energy consumption reduces the burning of fossil fuels and, thus, carbon emissions (Brown, 2019). This demonstrates the efficacy of BAS in facilitating climate change mitigation endeavors.
3. The implementation of Building Automation Systems (BAS) in resorts has resulted in a significant 20% enhancement in the comfort of both occupants and visitors. This not only demonstrates the energy efficiency of this technology but also highlights its ability to enhance the overall user experience by improving comfort levels. The implementation of Building Automation Systems (BAS) allows for enhanced control over indoor climate conditions and personalized lighting, resulting in increased customer satisfaction (Kumar & Lee, 2018).
4. Implementation constraints for BAS include significant initial expenses, the need for technical training, and challenges related to compatibility with existing systems. This challenge aligns with the conclusions of Yadav and Wu (2021), who demonstrate that the primary barriers to implementing BAS are typically technical and economic constraints. In order to surmount these challenges, it is necessary to implement a gradual investment plan and provide sufficient technical education.
5. Pragmatic suggestion: To maximize the advantages of BAS and address any limitations in its implementation, resort managers are advised to allocate resources to providing technical training for staff. Implement a phased investment strategy

to mitigate the initial financial load. Select a Building Automation System (BAS) that is compatible with the current infrastructure to prevent any potential interoperability problems.

In conclusion, the implementation of BAS in resorts in Bali has proven to provide significant benefits in improving energy efficiency, reducing carbon emissions, and improving the comfort of residents and visitors. Despite some obstacles, with the right strategy, BAS can be implemented more broadly to support sustainable operations in the hospitality sector. This research provides important insights and practical recommendations that resort managers can adopt to improve the sustainability of their operations.

6.2. Future Research Directions

This study has demonstrated that the integration of Building Automation Systems (BAS) in Balinese resorts can significantly enhance energy efficiency, reduce carbon emissions, and improve guest comfort. However, several avenues for further research remain that can build upon these findings.

Future studies could delve deeper into the cost-benefit analysis of BAS implementation across various resort types, ranging from budget to luxury resorts. Understanding the financial viability of BAS in different operational contexts will help resort managers make informed decisions. Additionally, research could explore the long-term financial benefits of BAS, including return on investment and operational cost savings, to provide a clearer picture of the economic sustainability of BAS adoption. Another potential avenue for exploration is the investigation of BAS's impact on different types of resorts—urban, coastal, or eco-resorts—each of which may have unique energy demands and operational challenges.

6.3. Summary of Key Contributions:

The key contributions of this study are multifold. First, it provides empirical evidence of the positive impact of BAS on energy efficiency, carbon footprint reduction, and occupant comfort in Balinese resorts, a sector that has been underexplored in the literature. Second, it highlights the operational challenges that resorts face in adopting BAS, such as high initial costs and the need for technical expertise, offering practical recommendations for overcoming these barriers. Lastly, this research underscores the role of BAS in supporting sustainability goals in the tourism sector, particularly in regions like Bali where tourism plays a crucial role in the economy and environmental sustainability.

By addressing these gaps, this study contributes to both theory and practice in sustainable hospitality management. The findings offer valuable insights for resort managers, policymakers, and environmental advocates, highlighting the practical and environmental benefits of BAS implementation in resort operations. In conclusion, while the adoption of BAS presents certain challenges, the potential benefits in terms of energy efficiency, carbon reduction, and guest satisfaction make it a valuable investment for the future of sustainable tourism.

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