GREEN ARCHITECTURE AS A DRIVER OF SUSTAINABLE DEVELOPMENT IN SMALL AND MEDIUM ENTERPRISES (SMES): INSIGHTS FROM BALI, INDONESIA

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ABSTRACT

This study explores the implementation of green architecture in Small and Medium Enterprises (SMEs) in Bali and its role in promoting sustainable development. SMEs, which significantly contribute to the local economy, are increasingly adopting eco-friendly practices to reduce their ecological footprint. Using a mixed-method approach, this study combines qualitative interviews with SME owners who have applied green architecture principles, such as energy-efficient design and sustainable materials, with quantitative data collected from 50 SMEs through structured surveys. The findings reveal that 70% of SMEs use environmentally friendly local materials, resulting in a 20-30% reduction in energy consumption through natural lighting and ventilation strategies. Additionally, 60% of SMEs have implemented an independent waste management system, leading to a 40% reduction in waste disposal. The study underscores that green architecture not only reduces environmental impact but also improves operational efficiency and market competitiveness, thereby leading to potential economic benefits. These results demonstrate that integrating sustainable architectural practices in SMEs can significantly support ecological sustainability while offering financial benefits. This research fills a gap in the existing literature by providing a model for adopting green architecture in the SME sector, especially in a tourist-driven economy like Bali. It offers valuable insights for policymakers and business owners, motivating them to adopt green architecture practices to enhance their market competitiveness.

Keywords: green architecture, SMEs, sustainable development, energy efficiency, Bali

1. INTRODUCTION

Small and medium enterprises (SMEs) play a crucial role in driving economic growth in various countries, including Indonesia. According to data from the Ministry of Cooperatives and Small and Medium Enterprises (Kemenkop UKM), SMEs account for around 60.34% of Indonesia's national gross domestic product (GDP) and create more than 97% of jobs nationwide. In Bali, the tourism sector is the central mainstay of the local economy, and most of the businesses that support the tourism industry are SMEs, such as hotels, restaurants, souvenir shops, and transportation services. Recognizing the significance of SMEs in the local economy, it becomes urgent for policymakers to support these businesses, especially in their adoption of sustainable practices like green architecture.

However, the rapid growth of this sector also hurts the environment. Bali faces serious challenges related to environmental degradation, including increased carbon emissions, declining water quality, deforestation, and high waste production. The Bali Environment Agency noted that the daily waste production level in Bali reached 4,281 tons/day, with more than 60% of solid waste coming from the tourism sector and SMEs. In addition, the increasing number of buildings for tourism accommodation has led to the use of environmentally unfriendly construction materials and high energy consumption, which impacts the region's carbon footprint. (UNEP, 2009; Unep-Sbci, 2010).

Given Bali's heavy reliance on tourism, sustainable development through green architecture can significantly impact the sector. By adopting green architecture, tourism-related SMEs can reduce their environmental impact while enhancing their appeal to eco-conscious tourists, thereby supporting the long-term sustainability of Bali's tourism industry.

Green architecture refers to designing and constructing buildings prioritizing environmental sustainability by minimizing non-renewable resources and maximizing energy efficiency. This includes using eco-friendly materials, energy-efficient designs, and sustainable technologies such as renewable energy sources and waste management systems. By incorporating natural elements and reducing the overall ecological footprint, green architecture aims to create built environments harmonizing with the natural world.

Green architecture is beginning to be recognized as a potential solution to overcome increasingly urgent environmental challenges. This approach includes using sustainable materials, reducing energy consumption, and integrating natural elements into the design of buildings to minimize adverse environmental impacts.

(McLennan, 2005; Mohammed, 2021). Some fundamental principles in green architecture include using sustainable materials, such as bamboo, recycled wood, or local materials with a low environmental impact. In addition, energy efficiency is in focus with the application of energy-saving technologies, such as natural lighting, cross-ventilation, and renewable energy, including solar panels. Another principle that is no less important is waste treatment, where a self-contained waste treatment system can reduce the burden of waste produced by buildings on the environment. (Huseynov, 2011; Khan et al., 2021; Sutar et al., 2022). With these principles, green architecture is expected to be a natural step towards achieving more sustainable development.

Although these principles have been widely applied to large commercial projects, their application to SMEs is still rare, especially in Bali. SMEs have great potential in adopting green architecture because of the flexible nature of their business and close to the local community. According to the International Finance Corporation (Suh et al., 2018; Wu et al., 2021)**,** SMEs that implement green architecture practices can reduce energy consumption by up to 30% and carbon emissions by 25%, which can also increase long-term profitability.

In Bali, SMEs play a crucial role in the economy, particularly tourism, handicrafts, and hospitality sectors. These sectors are particularly relevant to applying green architecture due to their significant environmental impact and potential for integrating sustainable practices. For instance, the tourism and hospitality industries, which rely heavily on Bali's natural beauty, can benefit from green architectural solutions that enhance environmental sustainability and improve the quality of tourist experiences.

Recent data from the Bali Environment Agency (2023) indicates that energy consumption in the region has risen by 15% over the past five years, with the tourism sector being a significant contributor. This underscores the urgent need for energy-efficient designs and sustainable practices, which green architecture can provide.

In addition, implementing green architecture in SMEs in Bali can provide double benefits, supporting environmental sustainability and improving the business image in the eyes of tourists. The World Tourism Organization (United Nation Wourld Tourism Organization, 2018) 72% of international tourists prefer to stay in places that follow environmentally friendly principles. This data shows that applying green architecture to SMEs is an ethical and profitable business strategy.

Unfortunately, few studies have examined how green architecture can be applied to SMEs in Bali, especially in supporting sustainable development. Most studies focus more on large commercial buildings or housing, while the SME sector, which contributes significantly to the economy and the environment, is still less explored.(Coma Bassas et al., 2020; Kusumawardhani et al., 2023; Mahendra et al., 2022; Sutar et al., 2022). Therefore, this study will examine the application of green architecture to SMEs in Bali and how it can support sustainable development in the region.

This research is urgent considering the growing growth of small and medium enterprises (SMEs) in Bali, especially in the tourism sector. Based on data from the Central Statistics Agency (BPS) Bali (2022), the number of SMEs in Bali has increased by more than 15% in the last five years, with around 60% of the total SMEs directly involved in the tourism industry. The sector uses Bali's abundant natural resources, but the lack of attention to the environmental impact of business activities has raised serious concerns about environmental sustainability. In this context, green architecture has great potential to be a solution to reduce the ecological footprint of SMEs through the application of environmentally friendly technologies, such as energy efficiency, sustainable use of materials, and better waste management. Gibberd (2002) Showed that green architectural design can reduce energy consumption by up to 30% and improve operational efficiency in the long term. However, the application of this concept to SMEs is still minimal, especially in Bali, which has unique economic and environmental characteristics.

Furthermore, in addition to having a positive impact on the environment, the implementation of green architecture can also increase the competitiveness of SMEs. A report from (United Nation Wourld Tourism Organization, 2018) Most international tourists prefer services from environmentally friendly businesses, meaning SMEs that apply green architectural principles can gain a competitive advantage in a tourism market increasingly concerned with sustainability issues. Therefore, it is essential to research how green architecture can be integrated into the business practices of SMEs in Bali to support sustainable development while maintaining Bali's tourism attractiveness at the global level.

Beyond environmental impacts, green architecture also contributes to economic and social sustainability by reducing operational costs through energy efficiency, enhancing market competitiveness by attracting environmentally conscious customers, and improving the well-being of local communities by creating healthier living and working environments. These benefits are particularly significant in the context of Bali's tourism-driven economy.

This study aims to (1) explore the impact of green architecture on reducing operational costs among MSMEs in Bali, (2) assess the role of green architecture in promoting environmental sustainability in the MSME sector, and (3) investigate how green architecture influences the market competitiveness of MSMEs in Bali's tourism industry. In summary, this study aims to analyze how green architecture is applied to SMEs in Bali and examine its role in supporting sustainable development in the sector. In addition, this study aims to provide recommendations to improve the application of green architecture in SMEs so that they can support environmental and economic sustainability. This research is expected to practically contribute to SME entrepreneurs adopting environmentally friendly practices through green architecture. On the other hand, this research can provide new insights for policymakers regarding the importance of supporting sustainable development in the SME sector.

Previous studies on green architecture have primarily focused on large commercial buildings and housing (e.g., Jones et al., 2019; Khan et al., 2021). However, few studies have examined its application in SMEs, particularly in a unique context like Bali. This research aims to fill this gap by providing insights into the challenges and benefits of implementing green architecture in the SME sector.

In addition, this research provides practical and policy benefits and fills gaps in the academic literature. Most studies on green architecture have focused more on large-scale commercial buildings and housing, while SMEs, especially in tourist areas such as Bali, have not been widely explored. Jones et al. (2019) This research gap is essential, as SMEs have great potential to contribute to sustainable development. Thus, this research is expected to fill in the gaps in the literature and provide a deeper understanding of the application of green architecture to SMEs in Bali to support sustainable development in the region.

This research adopts an interdisciplinary approach, integrating concepts from architecture, environmental science, and economics. By combining these disciplines, the study offers a comprehensive understanding of how green architecture can address environmental, economic, and social challenges faced by SMEs in Bali.

2. LITERATURE REVIEW

Sustainable development theory

The Brundtland Commission first formulated the sustainable development theory in the Our *Common Future* report in 1987. Sustainable development is defined as development that meets the needs of current generations without sacrificing the ability of future generations to meet their own needs (Visser et al., 2013). This concept emphasizes three interrelated pillars: economic, environmental, and social. In the economic dimension, sustainable development underscores the importance of inclusive and sustainable growth that can promote improved welfare without excessive depletion of natural resources. The environmental pillar focuses on preserving ecosystems, reducing carbon footprints, and maintaining the sustainability of natural resources for future generations. The social pillar highlights the importance of equitable and equitable development, in which the social well-being of communities is maintained, including through access to education, health, and equal economic opportunities. (M. Redclift, 1991; Michael Redclift, 2005, 2018).

In architecture and planning, this sustainable development theory is applied to create a built environment that supports the three pillars. Green architecture is one of the responses to this theory to minimize the environmental impact of buildings while supporting economic aspects through energy and social efficiency through inclusive and comfortable design for all levels of society. (Apostu et al., 2023; Mensah, 2019; Ozili et al., 2024; van Zanten et al., 2021). Therefore, sustainable development theory is a crucial cornerstone in various sustainability initiatives, including designing buildings for small and medium enterprises (SMEs), which play an essential role in the global economy.

In addition to the sustainable development framework, other relevant theories include industrial ecology, which examines the flow of materials and energy through industrial systems, and regenerative design, which focuses on creating systems that restore and renew their energy sources and materials. These theories further emphasize the relevance of green architecture as a holistic approach to sustainability.

Green architecture theory

The theory of green architecture was developed by (McLennan, 2005) In his book The Philosophy of Sustainable Design, he highlights the importance of designing buildings by considering their environmental impact. This theory emphasizes that green architecture should prioritize the efficient use of resources, reduce energy consumption, and utilize sustainable materials with a low environmental impact. McLennan noted that buildings should be designed to work harmoniously with natural ecosystems, using natural lighting, cross-ventilation, and renewable energy technologies such as solar panels or wind power. (Astoeti et al., 2021; Dolatabad et al., 2022; Ketut Acwin Dwijendra et al., 2023; McLennan, 2005; Yuan, Widjaja, et al., 2022).

In addition, green architecture also highlights the importance of reducing waste, both in the construction process and building operations. This can be done using recyclable materials and adopting an environmentally friendly waste management system. Khan et al. (2021; Mustika et al., 2021) Emphasized that by applying green architectural principles, buildings can significantly reduce their ecological footprint while improving energy efficiency and lowering operating costs. McLennan also noted the importance of integrating technology and innovation in the design of buildings, which not only supports sustainability but also improves the quality of life of its occupants (Yuan, Patra et al., 2022).

Green architecture directly supports the three pillars of sustainable development—economic, social, and environmental. Economically, it reduces operational costs by enhancing energy efficiency and using local materials, supporting local economies. Socially, green architecture contributes to the well-being of communities by creating healthier living and working environments through improved indoor air quality and natural light. Environmentally, it reduces the carbon footprint and minimizes waste production, aligning with the environmental pillar of sustainable development. Thus, green architecture is a practical application of sustainable development theory by providing a tangible framework for balancing these interconnected pillars."

SMEs as agents of sustainable development

SMEs have an essential role in fostering sustainable development, mainly because of their flexibility in adopting green innovations and solutions. According to (Suh et al., 2018)SMEs can become agents of change in applying innovative solutions in various sectors, including green architecture. Although often considered not to have enough resources to adopt green technology, SMEs can be pioneers in implementing eco-friendly design because of their smaller and flexible scale of operations. In the context of Bali, SMEs engaged in the tourism, hospitality, and handicraft sectors have an excellent opportunity to implement green architecture to increase competitiveness while supporting economic and environmental sustainability.

Green building rating system

Green building assessment systems, such as Leadership in Energy and Environmental Design (LEED), have become a global benchmark in assessing the successful implementation of green architecture. LEED provides guidance and standards for buildings to achieve energy efficiency, waste reduction, and sustainable use of materials (J. Kim, 1999; K. P. Kim et al., 2020; Y. J. Kim et al., 2017)The system assesses the technical aspects of the building and considers the resulting social and economic impact. Implementing this assessment system can help improve SMEs' business image, especially in the tourism sector, which increasingly prioritizes sustainability as a selling point. In Bali, SMEs implementing LEED standards can improve their reputation among tourists who care more about the environment.

The Leadership in Energy and Environmental Design (LEED) is a globally recognized certification system that provides a framework for identifying and implementing practical and measurable green building design, construction, operations, and maintenance solutions. For MSMEs, LEED can be applied by focusing on energy efficiency, the use of sustainable materials, and water conservation in their buildings. Achieving LEED certification, even at a basic level, can enhance the environmental performance of MSMEs while also improving their market competitiveness by appealing to eco-conscious customers.

Previous similar research

A study conducted by(Jones et al., 2019) Applying green architecture in the small-scale commercial sector can reduce energy consumption by up to 30% in Southeast Asia. This study shows that implementing energy-efficient design, sustainable use of materials, and efficient waste management systems positively impacts the environment and reduces business operational costs. This is relevant in the context of SMEs, especially in tourist areas such as Bali, where energy and environmental costs are the primary concerns. The study also highlights that SMEs that implement green architecture can improve operational efficiency without sacrificing the quality of their services.

Research conducted by (Khan et al., 2021) In Australia, it is shown that SMEs' adoption of green architecture significantly improves operational efficiency and reduces energy costs. The study found that SMEs that integrate eco-friendly design in their operations can save up to 25% on energy costs and reduce the carbon footprint of their business. The study also highlights that SMEs implementing green architecture have a higher competitive advantage than their competitors, especially in attracting customers who care more about the environment. These findings support the idea that implementing green architecture can be an effective business strategy for SMEs while supporting the global sustainability agenda.

3. METHOD

This study uses a mixed-methods approach that combines qualitative and quantitative methods to gain a comprehensive understanding of the application of green architecture in SMEs in Bali and its impact on operations and environmental sustainability. This approach aims to combine the power of qualitative data to understand the process of implementing green architecture and quantitative data to measure its impact more objectively. (J W Creswell, 2014; John W. Creswell et al., 2011; J.W. Creswell et al., 2018).

Data collection methods

This study uses two main data collection methods: in-depth interviews (qualitative data) and surveys (quantitative data).

1. In-Depth Interviews Qualitative data was collected through in-depth interviews with SME owners in Bali who have applied green architecture principles. This interview was conducted with 10 SME owners who were directly involved in the design and development process of their businesses using green architecture principles. The respondents are selected based on purposive sampling, which aims to select SME owners with direct experience in applying green architecture, such as using environmentally friendly materials, energy-saving design, and waste treatment. The interviews were conducted semi-structured, allowing for a deeper exploration of the motivations, challenges, and benefits business owners felt about green architecture implementation (Yin, 2009).
2. Survey Quantitative data was obtained through a survey of 50 respondents from various SMEs in Bali. The survey uses a closed questionnaire compiled to measure the impact of implementing green architecture on reducing operational costs, improving energy efficiency, and environmental sustainability. The questionnaire consisted of 20 items measured on a 5-point Likert scale, in which respondents were asked to assess the extent to which the implementation of green architecture impacted these aspects. This survey is designed to provide measurable data that can be analyzed statistically (Clark et al., 2021; Joshi, 2015).

Analysis methods

1. Qualitative Analysis Qualitative data from interviews were analyzed using thematic analysis techniques to identify recurring patterns and themes in applying green architecture in SMEs. This analysis is carried out through a coding process, where each interview is elaborated and coded based on the main themes that emerge, such as the owner's motivation to implement green architecture, the obstacles faced, and the perceived benefits. This technique allows researchers to discover essential patterns in the application of green architecture and how sustainability principles are applied in the context of SMEs in Bali(Braun et al., 2008).
2. Quantitative Analysis Quantitative data from the survey was analyzed using linear regression methods to test the relationship between the implementation of green architecture and the reduction of operational costs in SMEs. Linear regression was chosen because it allows the analysis of the cause-and-effect relationship between independent variables (application of green architecture) and dependent variables (reduction of operational costs and improvement of environmental sustainability). In addition, a Pearson correlation test was conducted to measure the strength of the relationship between these variables to determine to what extent the application of green architecture contributes to improving efficiency and sustainability in SMEs (Field, 2018).

Validity and reliability

To ensure the validity of qualitative data, in-depth interviews were conducted by data triangulation, namely by verifying the results of interviews from several different SME owners and by comparing the findings of the interviews with the results of quantitative surveys. In addition, the reliability of the survey questionnaire was tested using Cronbach's Alpha, where an alpha value above 0.7 was considered strong enough to ensure the internal consistency of the research instrument. (Field, 2018).

Through this mixed methods approach, this research is expected to provide in-depth insights and measurable data on the application of green architecture in SMEs in Bali and its impact on environmental and economic sustainability.

4. RESULT AND DISCUSSION

Result

This study uses a mixed-methods approach, with qualitative data collected through interviews and quantitative data analyzed using SPSS statistical software, to examine the relationship between the implementation of green architecture in SMEs in Bali and its impact on operational cost reduction and environmental sustainability. The following are the study's results in more detail and how statistical methods, specifically linear regression and Pearson correlation tests, are used to test the research hypothesis.

Use of eco-friendly materials

According to the survey results, as many as 70% of SMEs reported using environmentally friendly materials such as bamboo, recycled wood, and other local materials. A simple linear regression test was conducted to test the impact of this use on reducing operational costs.

In SPSS, the independent variable uses environmentally friendly materials, while the dependent variable is the reduction of operational costs. The linear regression results showed $R^2 = 0.45$, which means that using environmentally friendly materials can explain 45% of the variation in the reduction in operating costs. This shows a strong relationship between the use of sustainable materials and cost efficiency in SMEs. The regression coefficient ($B = -0.35$, $p < 0.05$) shows that the more SMEs use environmentally friendly materials, the more significant the reduction in their operational costs, with a 35% reduction in raw material costs.

Reduced energy consumption

In terms of reducing energy consumption, SMEs that implement energy-efficient designs such as natural lighting and cross-ventilation are reported to have succeeded in reducing energy consumption by 20-30%. A Pearson correlation test was conducted to test the relationship between energy-efficient design and reduced energy consumption.

The analysis with SPSS showed a strong positive correlation between the application of energy-saving design and the reduction of energy consumption with a value of $r = 0.65$ ($p < 0.01$). That is, there is a significant relationship between the two variables. The more SMEs apply energy-efficient design principles, the more significant the reduction in energy consumption they experience.

In addition, linear regression was carried out to measure the contribution of independent variables (energy-saving design) to dependent variables (reduction in energy consumption). The regression results showed $R^2 = 0.52$, meaning that applying energy-saving design could explain 52% of the variation in energy consumption reduction. The regression coefficient ($B = -0.42$, $p < 0.01$) shows that SMEs that implement energy-efficient designs experience an average 42% reduction in energy consumption.

Waste treatment

As many as 60% of SMEs reported using self-treatment systems to reduce environmental impact. Pearson's correlation test was used to test the relationship between implementing a self-treatment system and reducing the volume of waste discharged to landfills. The analysis results showed a moderate correlation between the two variables with a value of $r = 0.54$ ($p < 0.05$), which showed that the application of the self-treatment system contributed to a significant reduction in waste volume.

To deepen the analysis, a linear regression resulted in $R^2 = 0.47$, showing that applying a self-contained waste treatment system could explain 47% of the variation in waste reduction. The regression coefficient ($B = -0.38$, $p < 0.05$) shows that SMEs that implement self-treatment systems experience a waste reduction of 38% on average, thereby reducing the waste burden on the environment.

The results of the study analyzed through SPSS show that the implementation of green architecture in SMEs in Bali has a significant positive impact on reducing operational costs, energy savings, and waste management. Using Pearson's linear regression and correlation tests, it was found that 45% to 52% of the variation in cost and energy reduction could be explained by applying green architecture principles such as using environmentally friendly materials, energy-efficient design, and self-treatment of waste. These findings show that green architecture supports environmental sustainability and provides tangible economic benefits for SMEs.

Discussion

The application of green architecture in SMEs in Bali shows its effectiveness in reducing environmental impacts while providing economic benefits. The results of this study consistently support previous studies, such as the findings of (Coma Bassas et al., 2020; Masood et al., 2017; Well et al., 2021, 2022).This research shows that green architecture can significantly reduce energy consumption and operational costs. It also confirms that SMEs that apply environmentally friendly principles experience increased competitiveness due to an improved environmentally friendly business image.

Reduced energy consumption and operational efficiency

One of the study's key findings is that SMEs implementing energy-efficient designs, such as natural lighting and cross-ventilation, have reduced energy consumption by 20-30%. This aligns with the research of (Coma Bassas et al., 2020). Small-scale commercial buildings that implement green architecture in Southeast Asia have also reduced energy consumption by up to 30%. For SMEs in Bali, the most significant reduction in energy consumption occurred in the lodging sector (30%), followed by restaurants (25%) and handicraft shops (20%).

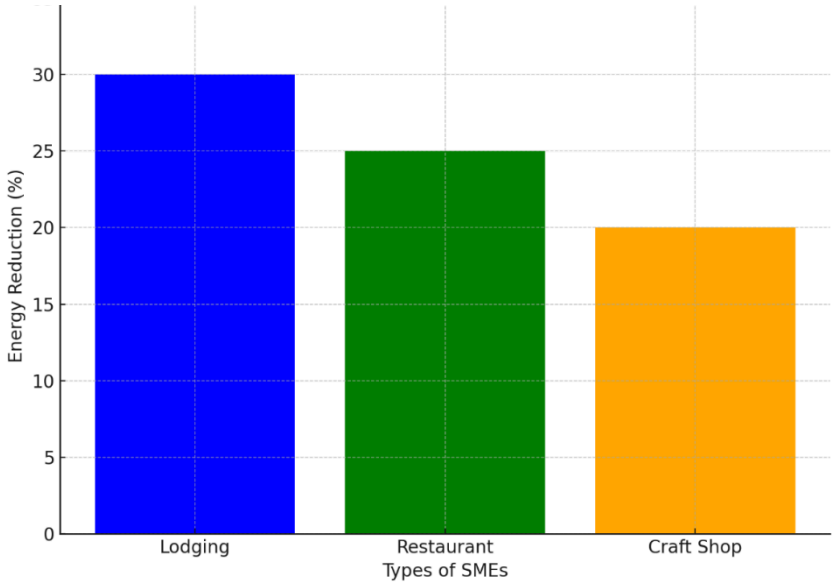

Figure 1. Reduction of energy consumption in various types of SMEs in Bali

Figure 1 shows a graph of energy consumption reduction in various types of SMEs in Bali. This graph illustrates that the lodging sector experienced the highest energy reduction of 30%, followed by restaurants at 25% and craft stores at 20%—this energy reduction results from applying energy-efficient design in green architecture in each type of SME.

The graph above shows how implementing energy-efficient designs, such as natural lighting, can significantly reduce energy consumption, especially in the lodging sector, which requires large amounts of energy for lighting and cooling. This is also reinforced by (Akadiri et al., 2012; Liu et al., 2018; McLennan, 2005; Yeang, 2010)This emphasizes that energy efficiency is one of the main components of green architecture, which can reduce buildings' energy loads.

Use of Eco-Friendly Materials

The study results show that 70% of SMEs implementing green architecture use local and environmentally friendly materials such as bamboo and recycled wood. These materials not only support environmental sustainability by reducing carbon footprint but also support the local economy by utilizing the available resources. These findings are consistent with McLennan's (2004) theory about the importance of using sustainable materials in green architecture.

In the context of SMEs, the use of local materials also provides cost advantages because it reduces dependence on imported materials and reduces transportation costs. (Ahmed et al., 2023; McLennan, 2005; Mohammed, 2021) They mentioned that SMEs have the flexibility to implement innovative solutions, including material selection, that contribute to their business's sustainability.

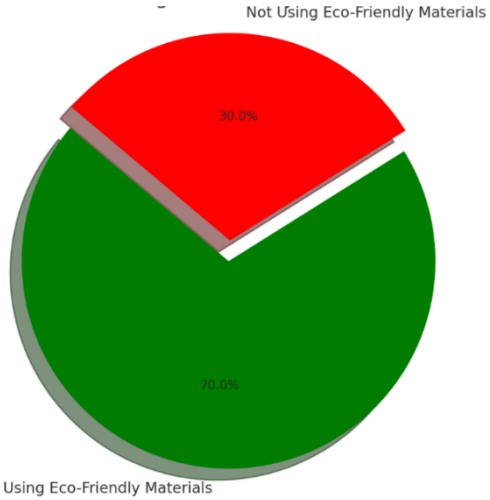

Figure 2. SME distribution using environmentally friendly materials based on survey results

The survey results, Figure 2, show that 70% of SMEs choose local materials such as bamboo and recycled wood, which the Miller & Buys (2010) study also identified as an essential factor in reducing operational costs. The use of these materials provides two main advantages: first, reducing the environmental impact of material exploitation, and second, reducing the cost of purchasing materials.

Waste treatment and its impact on the environment

As many as 60% of SMEs surveyed use self-treatment systems, which allow them to reduce the volume of waste disposed of in landfills by up to 40%. These results show that the implementation of green architecture impacts not only energy efficiency but also more sustainable waste management.

According to (McLennan, 2005; Yeang, 2010, 2022)Waste treatment is one of the main elements of green architecture. Self-contained waste treatment systems implemented by SMEs in Bali, such as wastewater recycling for irrigation and composting from organic waste, align with efforts to reduce environmental impact. Research by (Khan et al., 2021) An effective waste treatment system can reduce waste management costs and improve operational sustainability.

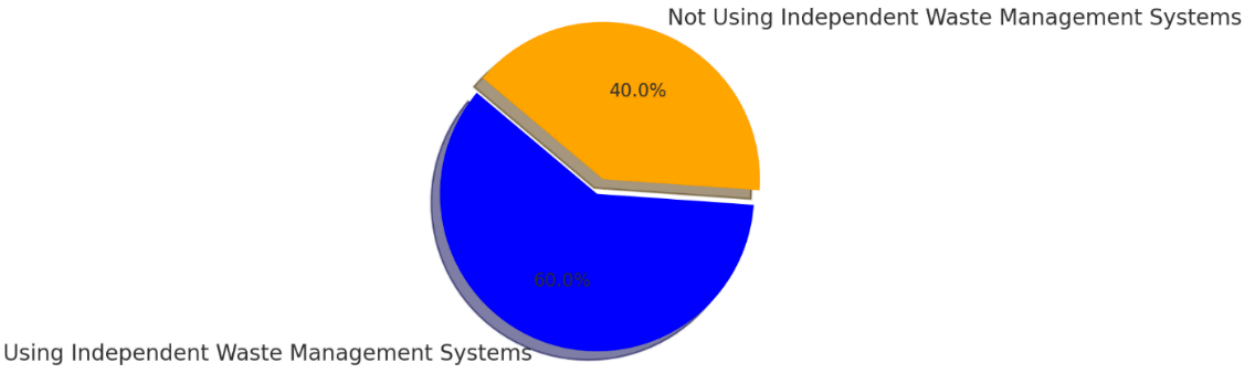

Figure 3. SMEs Distribution Using an Independent Waste Management System

Figure 3 shows that 60% of SMEs in Bali use an independent waste management system, while 40% do not. This data highlights the implementation of sustainable waste management practices among most regional SMEs.

The results of surveys and interviews show that SMEs that implement self-treatment systems manage to reduce waste by up to 40%, which contributes to reducing their environmental footprint. This supports a literature review that states that waste management is one of the essential pillars in achieving sustainability, as outlined in (Visser et al., 2013),

Image enhancement and competitiveness

Applying green architecture provides environmental and economic benefits and positively impacts the business image. The interviews showed that SMEs that applied green architecture principles reported

increased image in customers' eyes, especially tourists increasingly concerned about environmental sustainability. This is in line with the United Nations World Tourism Organization (2018), which states that 72% of international tourists prefer services from environmentally friendly businesses.

SMEs that successfully implement green architecture are reported to have higher competitiveness than their competitors who have not implemented the principle. This shows that green architecture is an environmental and effective business strategy to improve reputation and attract more environmentally conscious customers.

The above findings support the theories outlined in literature reviews, such as the theory of Sustainable Development. (Visser et al., 2013)**,** where green architecture in SMEs in Bali shows that the principles of sustainable development can be applied in the small business sector without sacrificing economic growth. Likewise, Green Architecture Theory (Coma Bassas et al., 2020; McLennan, 2005; Mohammed, 2021; Sutar et al., 2022; Well et al., 2022)**,** emphasizing that energy-efficient building design, sustainable use of materials, and waste treatment are critical pillars in creating more environmentally friendly buildings. These principles have proven effective in the context of SMEs in Bali.

Thus, the results of this study successfully answer the formulation of the problem that the application of green architecture can be the primary driver of sustainable development for SMEs in Bali, not only in terms of the environment but also in terms of economy and competitiveness.

5. CONCLUSION

This study clearly shows that applying green architecture can be a key driver in supporting sustainable development in small and medium enterprises (SMEs) in Bali. The results of this study answer the formulation of the problem, namely how green architecture can play a role in reducing environmental impacts and increasing operational efficiency in SMEs. By implementing green architectural practices, such as using sustainable materials, energy-efficient design, and self-treatment of waste, SMEs have reduced their ecological footprint and improved business performance by significantly reducing operational costs.

As many as 70% of SMEs surveyed use environmentally friendly materials such as bamboo and recycled wood, which helps reduce carbon footprint and material costs. SMEs that implemented energy-efficient designs, such as natural lighting and cross-ventilation, reduced energy consumption by 20-30%, with the lodging sector recording the highest reduction of 30%. In addition, 60% of SMEs use self-contained waste treatment systems, which can reduce waste by up to 40%. These findings show that green architecture is efficacious in improving environmental sustainability, operational efficiency, and reducing costs.

This research successfully achieves its objectives: to analyze how green architecture is applied in SMEs in Bali, measure its impact on environmental sustainability and operational efficiency, and provide recommendations to expand the application of green architecture to support sustainable development. The research also makes a practical contribution to SMEs by showing that applying green architecture can improve their competitiveness and business image. In addition, academically, this research fills a gap in the literature, which previously focused more on large commercial buildings or housing, by showing how green architecture can be applied effectively in the context of SMEs in tourism areas such as Bali.

Nonetheless, further research is needed to explore the economic and social impacts of implementing green architecture on SMEs in other regions. This research can be expanded to see how the application of green architecture affects economic growth, the well-being of surrounding communities, and changes in the material supply chain that are more sustainable.

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