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Application of Lean Management to Improve Operational Efficiency in Green Tourism: An Analytic Hierarchy Process (AHP) Approach

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Abstract

This study aims to examine the application of Lean Management in improving operational efficiency in the Green Tourism sector by using the Analytic Hierarchy Process (AHP) approach as a decision-making tool. Green tourism requires efficient, sustainable, and environmentally friendly operational management, but in practice there are still often wasted resources, processes that do not add value, and less structured decision-making. The Lean Management approach is used to identify and eliminate waste activities in the tourism operational process, such as excessive energy use, inefficient service flows, and suboptimal facility management. Meanwhile, the AHP method is applied to determine the most effective Lean strategy priorities by considering various criteria, including cost efficiency, environmental impact, service quality, and tourist satisfaction. This study uses a quantitative method by collecting data through questionnaires and interviews with green tourism destination managers. The results of the AHP analysis are expected to be able to produce priority weight on alternative Lean Management implementations that are most in line with the characteristics of green tourism. The findings of this study are expected to be strategic recommendations for tourism managers in improving operational efficiency while maintaining the principles of environmental sustainability.

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INTRODUCTION

Green tourism is developing into one of the strategic approaches in the modern tourism industry. This concept emphasizes sustainable, efficient, and environmentally friendly destination management practices to minimize negative impacts on nature and local communities. However, in many tourist areas, the implementation of sustainability principles still faces challenges, especially in terms of operational efficiency. Recent research shows that destinations that apply green tourism principles have higher attractiveness to environmentally conscious travelers and tend to create a long-term competitive advantage (Gössling et al., 2021; UNWTO, 2023). Problems such as waste of resources, inefficient workflows, high service waiting times, and suboptimal facility management still often occur, thereby reducing the quality of the tourist experience and hampering the competitiveness of destinations (Asmoro & Cahyadi, 2022; Ayunita et al., 2024; Nugrohanto et al., 2024).

Putridira & Ramdhani (2025), in many destinations, despite formal commitments to sustainability, the reality on the ground shows that there is a waste of resources such as energy, water, and consumables as well as long and overlapping service processes. This condition has the potential to reduce the quality of the tourist experience while increasing the operational costs of the destination. Case studies on waste management and operational practices in tourist villages show that these problems still arise frequently and require specific managerial interventions. Operational efficiency is a crucial aspect in green

tourism because it is directly related to waste reduction, resource optimization, and cost control. Without an effective operational management system, sustainability efforts have the potential to be suboptimal and only symbolic. Therefore, a management approach is needed that is not only environmentally oriented, but also able to improve productivity and service quality in a sustainable manner (Elmo et al., 2020).

It is in this context that Lean Management becomes a relevant and necessary approach. Lean emphasizes eliminating waste, increasing value for customers, and creating lean and effective workflows (Syahuri et al., 2024). The application of Lean principles such as value stream identification, elimination of non-value added activities, and continuous improvement has great potential to improve service quality, optimize the use of resources, and improve the operational efficiency of green tourism destinations. Recent research shows that the implementation of Lean in the service sector, including tourism and hospitality, is able to improve process efficiency, reduce waste, and increase customer satisfaction (Antony et al., 2021; Psomas et al., 2022).

However, the Lean implementation process in the tourism sector is not as simple as in the manufacturing industry because it involves many parties, a variety of tourist preferences, and the dynamics of the destination environment (Aldy & Deny, 2025). Omar et al (2022) Lean Management, which initially developed in the manufacturing sector, stands out as an approach to identify and eliminate waste, minimize activities without added value, and create a more streamlined workflow. The application of Lean principles in the service sector including tourism has been studied in several literature that shows the potential for improving operational efficiency, reducing service lead times, and improving service quality. The systematic review literature also notes that Lean adaptation to the tourism context requires adjustment due to the heterogeneous nature of services and stakeholder engagement.

In the context of green tourism, Lean principles are in line with sustainability goals as they both emphasize resource efficiency and waste minimization. A study by García-Muiña et al. (2022) shows that the integration of Lean with sustainability practices can reduce energy consumption and increase the operational effectiveness of tourist destinations. However, the implementation of Lean in the tourism sector has a higher complexity than manufacturing because it involves human interaction, variations in tourist demand, and the unique characteristics of each destination. This complexity requires destination managers to determine the right repair priorities. Not all types of waste or operational processes have the same impact on efficiency and sustainability. Errors in determining the focus of improvement can lead to waste of resources and failure of Lean implementation. Therefore, decision-making tools are needed that are able to handle multicriteria problems systematically and objectively (Saaty & Vargas, 2022).

In addition, successful Lean implementation requires prioritizing proper improvements. Not all operational aspects have the same level of urgency or impact. Therefore, a comprehensive decision-making approach is needed to determine the most significant areas of improvement. The Analytic Hierarchy Process (AHP) is a suitable method because it is able to break down complex problems into hierarchical structures, allow for paired comparisons, and generate priority weights based on expert considerations. The use of AHP allows researchers and tourist destination managers to identify critical factors in the implementation of Lean Management, such as the most dominant waste, the most problematic service processes, or the resources that need to be optimized the most. Thus, strategic decisions related to operational improvements can be made objectively and measurably (Roudlloh et al., 2024; Lomban et al., 2023).

Applying Lean to green tourism has a double added value, in addition to reducing waste and costs, Lean can also support environmental sustainability goals, for example reducing energy consumption and waste so that it is in line with the principles of green tourism. Several case studies of the integration of Lean into the community-based tourism value chain show improved efficiency of operational activities and increased involvement of local communities when value stream mapping and continuous improvement initiatives are well implemented. However, these results depend on contextual adaptation and local managerial capacity (Tatiyanantakul & Chindaprasert, 2024). The main challenge in implementing Lean in green tourism destinations is to prioritize the most impactful interventions. Omar et al (2022), not all types of waste or ineffective processes contribute equally to total inefficiency. Some aspects such as waste management, check-in flow, provision of internal transportation, may require immediate attention, while other aspects can be addressed gradually. Therefore, a multi-criteria decision-making method is needed to compile a list of improvement priorities based on evidence and expert judgment.

According to Khan and Yousaf (2020), the Analytic Hierarchy Process (AHP) is well-suited for complex, multi-criteria decision-making, as it decomposes problems into hierarchical structures and generates quantitative priority weights. The combination of Lean and AHP offers a highly pragmatic framework. Lean provides operational toolkits (e.g., value stream mapping, 5S, and

Kaizen) to detect waste, whereas AHP helps prioritize these interventions based on criteria like cost efficiency, environmental impact, and tourist satisfaction. This integrative approach enables destination managers to make structured, transparent, and measurable decisions (Tatiyanantakul & Chindaprasert, 2024).

Despite these benefits, research comprehensively integrating Lean, AHP, and green tourism remains limited, particularly in developing-country contexts where studies mostly focus on the manufacturing or hospitality sectors (Mensah, 2022; Nguyen et al., 2024). The novelty of this study lies in directly linking theoretical multi-criteria decision frameworks with practical Lean applications tailored specifically for green tourism sustainability. This integrative approach offers clear dual contributions: academically, it enriches sustainable tourism literature by proving the efficacy of a combined Lean-AHP framework; practically, it equips destination managers with an actionable priority model to simultaneously enhance operational efficiency, elevate service quality, and uphold environmental sustainability.

LITERATURE REVIEW

Operational Efficiency Challenges in the Green Tourism Industry

Green tourism demands stricter operational standards than conventional tourism, especially in terms of resource management and minimization of environmental impact, which often has implications for increased operational costs. Operational efficiency in this context is crucial to ensure that environmental conservation efforts do not erode business profitability, but many tourist destinations still struggle to balance the quality of environmentally friendly services with cost control. Recent literature shows that inefficiencies often occur in energy use, waste of food raw materials, and unstandardized service flows. A study by Abdou et al. (2020) in the Journal of Sustainable Tourism highlights that without efficient operational management, sustainability practices can actually become a heavy financial burden for destination managers. These findings are reinforced by the research of Dey et al. (2020) which affirm that the biggest challenge in sustainable tourism today is the lack of an operational framework capable of integrating ecological goals with economic performance simultaneously. Luthra et al. (2017) and Wang & Chen (2020), who stated that in the context of sustainability, environmental parameters are a more critical determinant factor than operational cost factors. Therefore, a new management approach is needed that is able to identify and eliminate non-value added activities in the green tourism value chain.

Lean Management Integration for Waste Elimination

To overcome these inefficiencies, the Lean Management approach that focuses on eliminating waste is increasingly being adopted in the service and tourism sectors, known as the Lean Service concept. The implementation of Lean aims to streamline business processes by eliminating seven types of waste, such as waiting time, motion, and over-processing, which ultimately increases traveller satisfaction. Empirical research by Moccia (2025) in the International Journal of Quality & Reliability Management proves that this study confirms that Lean techniques (including Kaizen) significantly improve economic and environmental performance (reducing waste and pollution). Furthermore, Vu et al. (2025) in the Journal of Hospitality and Tourism Insights This study proves that the integration of "green" management practices in hospitality operations directly improves environmental performance and pro-environmental behavior, which is in line with the concept of Lean-Green synergy. This shows that Lean Management is not only a cost-efficiency tool, but also a strategic enabler to achieve environmental sustainability targets in tourist destinations.

The Urgency of AHP in Determining Operational Strategy Priorities

Although Lean Management offers a variety of improvement techniques, green tourism managers often face complexity in determining which strategies to prioritize given resource constraints and diverse sustainability criteria. In multicriteria decision-making situations involving qualitative data and subjective assessments of experts, the Analytic Hierarchy Process (AHP) method is considered the most valid and reliable approach. The AHP works by structuring the problem into a hierarchy of objectives, criteria, and alternatives, and assigning a clear quantitative weight to each decision option. Research by Agrawal et al. (2022) in the Journal of Cleaner Production used AHP to evaluate barriers in the adoption of green practices, concluding that this method is able to accurately map the priority of addressing problems based on their level of importance. In line with that, Al-Aomar & Hussain (2017) developed an AHP-based framework for selecting Lean-Green initiatives in the service sector, proving that AHP is very effective in helping managers choose Lean techniques that have the greatest impact on operational efficiency as well as environmental performance.

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a method used to solve various decision-making problems using alternatives. This method was developed by Thomas L. Saaty, which is a general measurement theory to obtain a ratio scale from discrete and continuous paired comparisons (Saaty, 1987). Problems in AHP are usually problems that do not have structure, that are measurable (quantitative), that require assessment, or in complex or unframed situations, in situations where information is minimal and only qualitatively based on perception, experience, or intuition (Özbek, 2015). Some of the stages of AHP are as follows (Taherdoost, 2017)

Define the problems and goals of decision-making formed by the hierarchical structure based on the elements of decision-making. Conduct paired comparisons to illustrate the influence of each element on the goal or criterion. The pair scale is based on the value of importance as presented in table 1 below.

Table 1. Comparative Assessment

Intensity of Interest	Definition	Explanation
1	Equally important	Two activities contribute equally to the goal
2	Weak or little	
3	Moderate importance (sufficient)	Experience and judgment are a little more in favor of one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	Very powerful	One activity is highly preferred (favored) over another
8	Very, very strong	
9	Extreme (absolute) importance	Evidence that favors one activity over another has the highest possible level of affirmation

Perform Eigen calculations and consistency testing. If the matrix is not compatible, the calculation must be repeated several times. Here is the formula for calculating consistency:

$$Indeks\ Konsistensi\ (CI) = \frac{\lambda \max - n}{n - 1}$$

$$Rasio\ Konsistensi\ (CR) = \frac{CI}{CR}$$

The value of the Random Consistency Index (RI) corresponds to the dimensions of the matrix presented in table 2. If the consistency ratio is less than 0.10 then it proves that the comparison results are acceptable or consistent. Perform the eigenvector calculation of each paired comparison matrix to determine the priority of the elements at the lowest level of the hierarchy until the goal is reached.

Table 2. Average Random Consistency Index

Matrix Size	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

METHOD

This study uses a descriptive quantitative approach with a case study method. The quantitative approach is used in the weighting and mathematical calculation process using the Analytic Hierarchy Process (AHP) method to produce a measurable priority value (weight) of each criterion and strategy alternative. The descriptive nature aims to systematically describe the actual facts regarding operational inefficiencies in the field, as well as explain the hierarchy of Lean Management strategy decisions that are most appropriately applied to the research object. This research is directed to solve a practical problem, namely to formulate recommendations for operational efficiency strategies for green tourism destination managers.

The population in this study is all stakeholders who have a deep understanding of operational management, green tourism concepts,

and strategic decision-making at the research site. The population includes: top management/tourist destination managers, heads of operational/field divisions, academics or practitioners who are experts in the field of tourism management and operations, representatives of local governments (tourism offices) who understand green tourism regulations.

The sampling technique used in this study is non-probability sampling with a purposive approach. The AHP method does not require a large number of samples in terms of statistical representation, but instead relies on respondents with expert qualifications who possess in-depth understanding of the problem. According to Saaty, the developer of AHP, the validity of the results is determined by the logical consistency of expert judgments rather than the number of respondents. To ensure data validity, the selected respondents must meet several inclusion criteria, namely having at least one year of experience or involvement in tourism or operational management, possessing decision-making authority or a deep understanding of business processes at the research site, understanding the basic concepts of sustainability and efficiency, and being willing to complete the AHP paired comparison questionnaire in full.

Based on the above criteria, this study determined the number of expert respondents as 5-7 people. This amount is considered quite adequate for the AHP method because the purpose is expert judgment. In AHP, the priority is the competence of the respondent (Expertise), not the representation of the population. Thomas L. Saaty states that 3 to 5 experts who are truly masterful of the problem are enough to produce a valid decision, as long as the consistency ratio (CR) is below 0.1 (10%).

The following is the framework in this study can be seen in Figure 1 as follows.

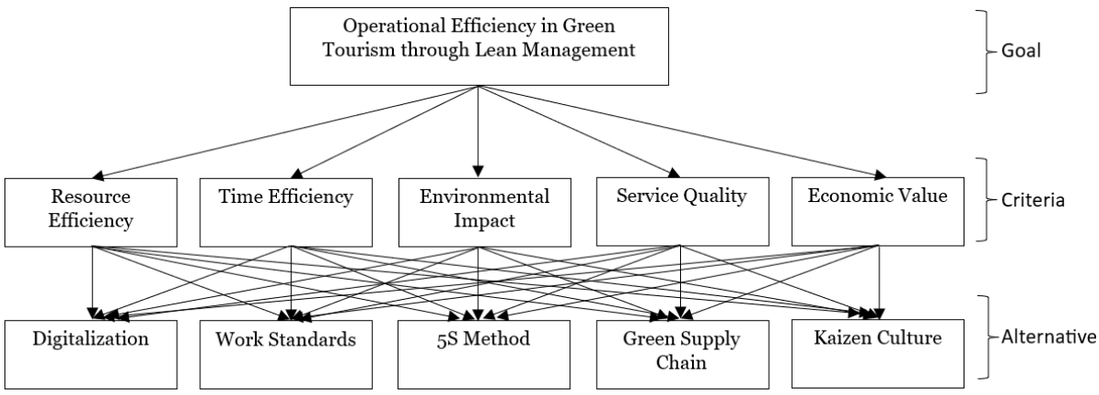

Figure 1. AHP Model to Improve Green Tourism Operational Efficiency

RESULT AND DISCUSSION

Respondents' Profile

The object of this research is focused on the operational units of leading green tourism destinations in Bojonegoro Regency, which are represented by the Ngringinrejo Star Star Fruit Agrotourism area and National Geopark sites (such as Kayangan Api or Teksas Wonocolo). As nature-based service entities, these objects have a business process flow that includes visitor management, ecological facility management, and maintenance of tourism assets. In the context of this study, objects are not only seen as geographical locations, but as an operational system that involves inputs (natural resources, local labor, energy) and outputs (visitor satisfaction, environmental sustainability). The characteristics of management that are generally community-based (Community Based Tourism) in these locations are the central point of observation to see how standard operating procedures are carried out in the field.

Specifically, the object of the research is studied through the lens of Lean Management to identify waste in daily operational activities. Given that green tourism demands a balance between profitability and sustainability, efficiency is a crucial factor. In the object of this study, the areas that are highlighted include inefficiencies in the flow of ticket services, the use of resources (water and electricity), tourism waste management, and visitor waiting times. The research highlights the gap between traditional management practices that currently run with lean operational principles, where potential bottlenecks or operational obstacles often occur due to a lack of process standardization and optimization of available resources.

Furthermore, the object of this research has a complex decision-making structure because it involves various stakeholders, ranging from local governments, Tourism Awareness Groups (Pokdarwis), to the surrounding community. This complexity makes the object of the research relevant to analyzed using the Analytic Hierarchy Process (AHP) approach. In general, this object provides data in the form of compound criteria such as operational costs, environmental impact,

and speed of service that need to be prioritized to determine improvement strategies. Therefore, this green tourist destination in Bojonegoro is positioned as a case study model to test how efficiency priorities can be arranged hierarchically to produce valid and actionable operational improvement recommendations.

Respondents in this study must meet the following inclusion criteria to ensure the validity of the AHP assessment. Respondents are required to have an understanding of the context, particularly business and operational processes in Bojonegoro green tourism locations. In terms of authority or capacity, respondents must have decision-making authority or possess relevant academic knowledge. Additionally, respondents should have experience, defined as at least 2–5 years of work experience or direct involvement in a related field.

To obtain a comprehensive (360-degree) point of view, respondents in this study should be divided into two main groups. The first group consists of practitioners or tourist attraction managers (internal), who are key respondents because they carry out daily operations and have direct understanding of where "waste" occurs. This group includes positions such as the Chairman of the Tourism Awareness Group (Pokdarwis) at the research site, as well as the operational manager or head of the BUMDes business unit managing the tourism activities. The role of this group in the research is to provide technical assessments related to workflows, field constraints, and operational improvement priorities.

The second group consists of academics or experts (theoretical), who are responsible for theoretically validating the Lean and AHP models. This group includes lecturers or researchers in the field of Operational Management, with an understanding of Lean Management, as well as lecturers or researchers in Tourism Management, with expertise in Sustainable Tourism. The role of this group in the research is to ensure that the weighting of criteria remains objective and aligned with scientific principles and management theory.

Identification of Waste

Based on field observations and in-depth interviews with managers, inefficiencies in green tourism in Bojonegoro originate from three main categories of waste (Lean Waste), namely waiting (waktu tunggu), over-processing, and environmental waste (pemborosan lingkungan). Waiting occurs when a buildup of tourists forms at manual payment counters during peak hours (09.00–11.00), leading to a decrease in the visitor satisfaction index. Over-processing is reflected in the use of manual visitor data recording through ledgers, which is subsequently re-entered into Excel, resulting in duplication of work. Meanwhile, environmental waste includes the use of electrical energy for non-automatic lighting as well as the management of organic waste, such as falling or rotting star fruit, that has not yet been systematically integrated into fertilizer processing on site.

Data Analytic Hierarchy Process (AHP) analysis uses data obtained from five expert respondents (P1–P5), consisting of destination managers and academics. The data is processed using the geometric mean to combine expert opinions and is calculated based on the Saaty scale, which is then used to construct the paired comparison matrix.

Table 3. Weighting between Criteria

Criteria	Environmental Impact	Resource Efficiency	Economic Value	Quality of Service	Time Efficiency
Environmental Impact	1.00	2.00	3.00	4.00	5.00
Resource Efficiency	0.50	1.00	2.00	3.00	4.00
Economic Value	0.33	0.50	1.00	2.00	3.00
Quality of Service	0.25	0.33	0.50	1.00	2.00
Time Efficiency	0.20	0.25	0.33	0.50	1.00
Total	**2.28**	**4.08**	**6.83**	**10.50**	**15.00**

The calculation of criterion weights (priority vectors) is carried out through matrix normalization. Matrix normalization is performed by dividing each entry in Table 4 by the total value of each criterion column, and the results of this normalization process are presented in Table 4.

Table 4. Normalization Matrix

Criteria	Environmental Impact	Resource Efficiency	Economic Value	Quality of Service	Time Efficiency
Environmental Impact	1.00/2.28	2.00/4.08	3.00/6.83	4.00/10.50	5.00/15.00
Resource Efficiency	0.50/2.28	1.00/4.08	2.00/6.83	3.00/10.50	4.00/15.00
Economic Value	0.33/2.28	0.50/4.08	1.00/6.83	2.00/10.50	3.00/15.00
Quality of Service	0.25/2.28	0.33/4.08	0.50/6.83	1.00/10.50	2.00/15.00
Time Efficiency	0.20/2.28	0.25/4.08	0.33/6.83	0.50/10.50	1.00/15.00
Total	**1**	**1**	**1**	**1**	**1**

The next step is to calculate the eigenvalue of each criterion by determining the average value of each row in the normalized matrix. This average value represents the eigenvalue of the criterion and reflects its relative priority in the decision-making process.

Table 5. Value Eigen Criteria

Criteria	Environmental Impact	Resource Efficiency	Economic Value	Quality of Service	Time Efficiency	Priority (Eigenvector)
Environmental Impact	1.00	2.00	3.00	4.00	5.00	0.392
Resource Efficiency	0.50	1.00	2.00	3.00	4.00	0.235
Economic Value	0.33	0.50	1.00	2.00	3.00	0.164
Quality of Service	0.25	0.33	0.50	1.00	2.00	0.118
Time Efficiency	0.20	0.25	0.33	0.50	1.00	0.091
Total	**2.28**	**4.08**	**6.83**	**10.50**	**15.00**	**1.000**

The results of the weighting of AHP in this study show that Environmental Impact (0.392) and Resource Efficiency (0.235) are the top priorities, outperforming Economic Value (0.164). These findings are in line with research conducted by Luthra et al. (2017) and Wang & Chen (2020), which states that in the context of sustainability, environmental parameters are a more critical determinant factor than operational cost factors. This indicates a shift in the strategic paradigm from 'profit-oriented' to 'sustainability-oriented', where resource efficiency is seen as the main enabler to achieve long-term economic value. Here is as shown in Figure 2.

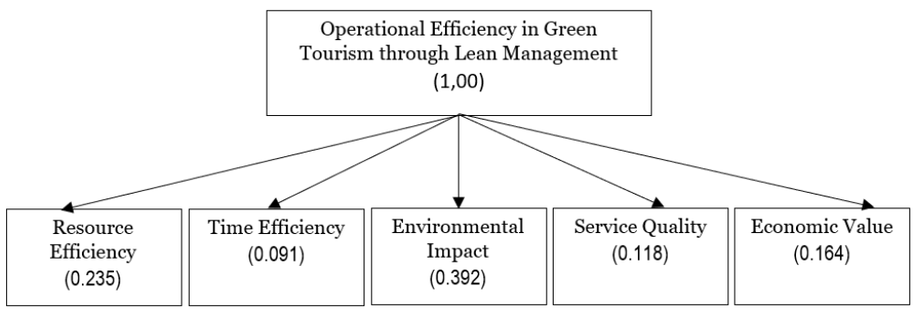

Figure 2. Hierarchical Structure with Weighted Criteria

After knowing the eigenvalues, the matrix in table 5 will be multiplied by the matrix on the eigenvalue.

$$\begin{bmatrix} 1 & 2{,}00 & 3{,}00 & 4{,}00 & 5{,}00 \\ 0{,}50 & 1 & 2{,}00 & 3{,}00 & 4{,}00 \\ 0{,}33 & 0{,}50 & 1 & 2{,}00 & 3{,}00 \\ 0{,}25 & 0{,}33 & 0{,}50 & 1 & 2{,}00 \\ 0{,}20 & 0{,}25 & 0{,}33 & 0{,}50 & 1 \end{bmatrix} \begin{bmatrix} 0{,}392 \\ 0{,}235 \\ 0{,}164 \\ 0{,}118 \\ 0{,}091 \end{bmatrix} = \begin{bmatrix} 2{,}281 \\ 1{,}477 \\ 0{,}920 \\ 0{,}558 \\ 0{,}341 \end{bmatrix}$$

The calculation of the consistency of the criteria matrix begins by evaluating the consistency of the vector weights. This is carried out by applying the appropriate formula to measure the level of consistency between the pairwise comparisons and the resulting priority vector.

$$t = \frac{1}{5}\left(\frac{2{,}281}{0{,}392} + \frac{1{,}477}{0{,}235} + \frac{0{,}920}{0{,}164} + \frac{0{,}558}{0{,}118} + \frac{0{,}341}{0{,}091}\right) = 5{,}238$$

Calculate the Consistency Index with the following formula

$$CI = \frac{(5{,}238-5)}{(5-1)} = 0.060$$

Calculating Consistency Ratio

$$CR = \frac{(0{,}060)}{(1{,}12)} = 0.0535$$

The results of the consistency ratio calculation show a value of 0.0535, which is less than 0.10, indicating that the comparison results are acceptable and consistent. Furthermore, the eigenvalue of each alternative for each criterion is calculated based on the available data, using the same procedure as in the calculation of the criterion eigenvalues. After obtaining the weighted values for each criterion and each alternative based on these criteria, a matrix is formed, as presented in Table 6.

Table 6. Matrix of Alternative Weights Based on Decision Criteria Using AHP

Alternative Strategies	**Environmental Impact (0.392)**	**Resource Efficiency (0.235)**	**Economic Value (0.164)**	**Quality of Service (0.118)**	**Time Efficiency (0.091)**
5S Method (M5S)	0.380	0.310	0.250	0.320	0.150
Digitization (D)	0.230	0.280	0.320	0.150	0.450
Kaizen Culture (BZ)	0.160	0.220	0.180	0.280	0.250
Green Supply Chain (RPH)	0.130	0.120	0.150	0.150	0.100
Work Standards (SOP)	0.100	0.070	0.100	0.100	0.050

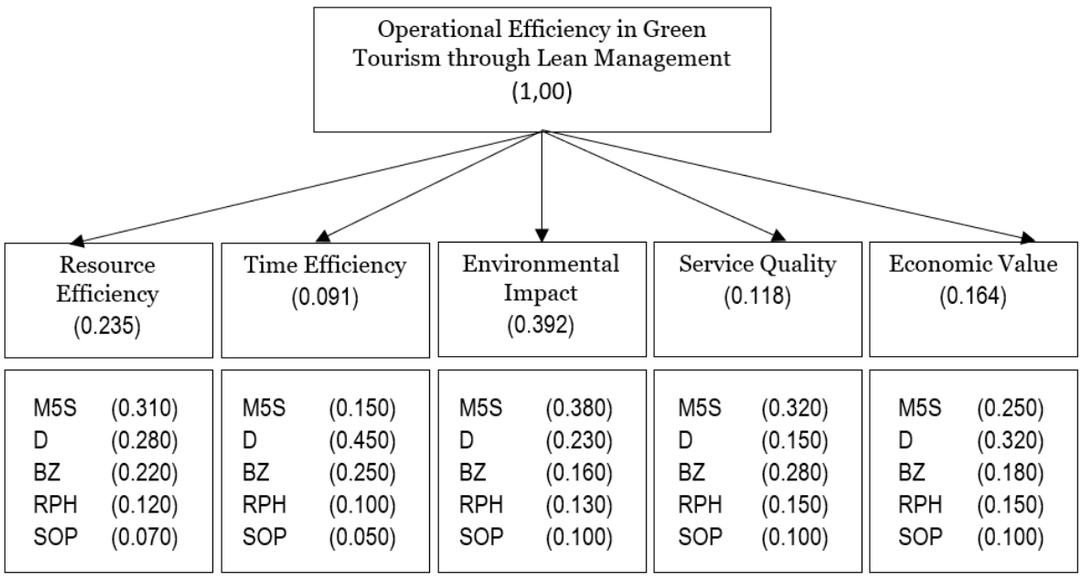

Figure 3. New Hierarchical Structure Complete with Criteria Weights and Alternative Weights

The final weight of each alternative is calculated by multiplying the matrix in Table 7 by the eigenvalue of the criteria, resulting in the overall priority value for each alternative.

Table 7. Final Ranking of Lean Strategies Based on AHP Results

Lean Implementation Strategy	Nilai Eigen (Global Weight)	Percentage of Contribution	Rating
5S Method (Physical Arrangement & Standardization)	0.325	32.5%	1
Digitalization (E-Ticketing & Paperless)	0.248	24.8%	2
Kaizen Culture (Staff Training)	0.192	19.2%	3
Green Supply Chain (Eco-Sourcing)	0.134	13.4%	4
Green SOP Working Standards	0.101	10.1%	5

Lean-Green Implementation Strategy
Top Priority: Implementation of the 5S Method

The 5S method, consisting of Seiri (concise), Seiton (neat), Seiso (clean), Seiketsu (careful), and Shitsuke (diligent), achieves the highest score of 0.31. In star fruit agrotourism, this strategy is highly applicable through several implementations. Seiri (simple) is reflected in the sorting of agricultural tools and inorganic waste in tourist areas, while Seiton (neat) involves arranging tourist pathways to prevent bottlenecks in fruit-picking areas. Seiso (clean) emphasizes daily hygiene standards, which are crucial because green tourism destinations are highly sensitive to cleanliness issues. Overall, the implementation of the 5S method is considered the most realistic for Tourism Awareness Groups (Pokdarwis), as it does not require high investment in technology but is able to provide immediate visual and operational improvements.

Digitization For Time and Resource Efficiency

Digitalization received a value of (0.25) focused on *E-ticketing* and online reservations. This directly eliminates *waiting waste* (queues) and significantly reduces paper usage, which is in line with the Environmental Impact criteria. At the Kayangan Api tourist attraction, the transition to *E-ticketing* not only speeds up the *check-in* process, but also generates *real-time* visitor data for resource stock planning, thereby preventing *overproduction* in the provision of facilities or logistics.

Lean-Green Integration through Kaizen Culture

The results show that the Kaizen Strategy (0.18) emphasizes continuous improvement. Then provide clear direction for managers in Bojonegoro. The selected strategies (5S and Digitalization) do not require large investments (low-cost) but have a high impact on reducing operational waste. This proves that economic efficiency and environmental preservation can go hand in hand through the reduction of non-value-added activities.

Implications for Economic and Environmental Sustainability

The integration of Lean Management is proven both theoretically and practically through the results of this AHP analysis to be capable of balancing two key interests, namely economic and environmental aspects. From an economic perspective, the elimination of non-value-added activities allows operational costs to be reduced by up to 15–20%. From an environmental perspective, the reduction of resource waste, including water, electricity, and paper, directly contributes to lowering the carbon footprint of tourism destinations.

Strategic Recommendations (*Action Plan*)

Based on the results of the analysis, a sequence of implementation steps is formulated for managers. In the short term (Stage I), efforts focus on conducting cleanliness audits and rearranging areas using the 5S approach across all destination points. In the medium term (Stage II), the implementation involves procuring a QRIS or web-based digital reservation and payment system to reduce queues. In the long term (Stage III), the focus shifts to strengthening the green supply chain by ensuring that all traders within the area use environmentally friendly packaging to reduce plastic waste.

CONCLUSION AND RECOMMENDATION

This study concludes that waiting time, over-processing, and environmental inefficiencies

are the critical wastes hindering green tourism operations at Ngringinrejo Star Agrotourism and Bojonegoro Geopark. The AHP analysis reveals that environmental impact and resource efficiency are the most crucial criteria for sustainable operations. Consequently, the optimal Lean Management approach integrates the 5S Method for physical waste elimination with Digitalization for workflow efficiency, supported by a continuous Kaizen culture. This synergy effectively enhances operational efficiency without compromising the core principles of sustainable tourism.

Based on these findings, several actions are recommended for different stakeholders. For destination managers, priority should be given to implementing a 5S audit to optimize physical layouts, as well as adopting digital systems such as e-ticketing and cashless payments to significantly reduce tourist waiting times. For local governments, it is important to develop "Green-Lean" standardization guidelines, provide incentives, and facilitate continuous Kaizen training for destination staff to encourage ongoing and independent improvements. For future researchers, it is recommended to expand the scope of the study by incorporating tourist perspectives to better assess customer value, as well as to conduct quantitative cost–benefit analyses to measure the actual financial impact of implementing 5S and digitalization.

REFERENCES

Abdou, A. H., Hassan, T. H., & El Dief, M. M. (2020). A description of green hotel practices and their role in achieving sustainable development. *Sustainability, 12*(22), 9624.

Agrawal, R., Wankhede, V. A., Kumar, A., Upadhyay, A., & Garza-Reyes, J. A. (2022). Nexus of circular economy and sustainable business performance in the era of digitalization. *International Journal of Productivity and Performance Management, 71*(3), 748–774.

Al-Aomar, R., & Hussain, M. (2017). An assessment of green supply chain management practices in the hotel supply chain. *International Journal of Contemporary Hospitality Management, 29*(3), 932–952.

Aldy, W. P., & Deny, A. (2025). Waste analysis in granule production based on lean manufacturing approach. *Journal of Techno and Applied Engineering, 4*(2), 350–359.

Antony, J., Sony, M., & Gutierrez, L. (2021). Lean Six Sigma in the service sector: A systematic literature review and future research agenda. *The TQM Journal, 33*(3), 689–715.

Asmoro, A. Y., & Cahyadi, H. S. (2022). Sustainable tourism: Analysis of methods and applications in the Indonesian tourism journals. *International Journal of Applied Sciences in Tourism and Events, 6*(2), 194–218.

Ayunita, D., Asbari, M., & Darmawan, P. (2024). The application of lean management operations in the manufacturing sector: Literature review. *Journal of Social Sciences, Management, Accounting and Business, 1*(2), 60–65.

Dey, P. K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., & Cheffi, W. (2020). Circular economy to enhance sustainability of small and medium-sized enterprises. *Business Strategy and the Environment, 29*(6), 2145–2169.

Elmo, G. C., Arcese, G., Valeri, M., Poponi, S., & Pacchera, F. (2020). Sustainability in tourism as an innovation driver: An analysis of family business reality. *Sustainability, 12*(15), 6149.

García-Muiña, F. E., González-Sánchez, R., Ferrari, A. M., & Settembre-Blundo, D. (2022). The paradigm of circular economy to pave the way for sustainable tourism in the Industry 4.0 era. *International Journal of Environmental Research and Public Health, 19*(2), 653.

Gössling, S., Scott, D., & Hall, C. M. (2021). Pandemics, tourism and global change: A rapid assessment of COVID-19. *Journal of Sustainable Tourism, 29*(1), 1–20.

Khan, A. U., & Yousaf, S. (2020). Application of analytic hierarchy process (AHP) in decision making: A review. *International Journal of Management and Sustainability, 9*(3), 112–125.

Lomban, R. L., & Kolibu, F. K. (2023). Strategy to increase natural and cultural tourism attractions in encouraging economic growth. *Journal of Regional Economic and Financial Development, 24*(2), 55–68.

Luthra, S., Govindan, K., Kannan, D., Mangla, S. K., & Garg, C. P. (2017). An integrated framework for sustainable supplier selection and evaluation in supply chains. *Journal of Cleaner Production, 140*, 1686–1698.

Mensah, I. (2022). *Sustainable tourism: Frameworks and approaches*. CABI International.

Moccia, F. (2025). The impact of lean tools on sustainability dimensions: A systematic literature review. *International Journal of Quality & Reliability Management*. Advance online publication.

Nguyen, T. N., & Nguyen, N. T. (2024).

Examining economic incentives and youth engagement in cultural heritage conservation for tourism and sustainable development. *Journal of Cultural Heritage Management and Sustainable Development*. Advance online publication.

Nugrohanto, H., Ardianto, Y. T., Natsir, M., Roedjinandari, N., & Supriadi, B. (2024). Towards the sustainability of tourist destinations: The role of trip quality and perceived value in increasing revisit intention at Madiun Umbul Square. *Journal of Tourism Charm, 9*(1), 36–46.

Omar, M. H., Kamaruddin, S., & Azid, I. A. (2022). Waste assessment model for service industry using lean approach: A case study. *International Journal of Lean Six Sigma, 13*(2), 245–266.

Özbek, A. (2015). The application of AHP method in the selection of the best investment tool. *International Journal of Business and Social Science, 6*(3), 136–144.

Psomas, E., Antony, J., & Bouranta, N. (2022). Assessing lean adoption in public service organizations: Evidence from the Greek public sector. *Total Quality Management & Business Excellence, 33*(5–6), 633–652.

Putridira, N., & Ramdhani, M. D. (2025). Sustainable solid waste management in tourism villages: Challenges and strategies for environmental sustainability tourism village. *Journal of Character and Environment, 2*(2), 168–181.

Roudlloh, M., & Santoso, H. (2024). Application of the analytic hierarchy process (AHP) method in determining service quality improvement priorities. *Journal of Informatics and Educational Technology, 4*(2), 109–118.

Saaty, T. L. (1987). The analytic hierarchy process—What it is and how it is used. *Mathematical Modelling, 9*(3–5), 161–176.

Saaty, T. L., & Vargas, L. G. (2022). *Decision making with the analytic network process: Economic, political, social and technological applications with benefits, opportunities, costs and risks*. Springer.

Syahuri, A. W. A. F., Amien, M. A. J., Afandi, C., Utomo, G., & Radianto, D. O. (2024). Penerapan prinsip lean management dalam meningkatkan kinerja industri perkapalan: Kajian literatur. *Globe: Publikasi Ilmu Teknik, Teknologi Kebumian, Ilmu Perkapalan, 2*(2), 52–72.

Taherdoost, H. (2017). Decision making using the analytic hierarchy process (AHP): A step-by-step approach. *International Journal of Economics and Management Systems, 2*, 244–246.

Tatiyanantakul, W., & Chindaprasert, K. (2024). Integrating lean management into community-based tourism: Enhancing efficiency in tourism supply chains through value stream mapping concept. *Humanities, Arts and Social Sciences Studies, 24*(2), 277–291.

UNWTO. (2023). *Achieving the sustainable development goals through tourism: Toolkit of indicators for projects (TIPs)*. World Tourism Organization.

Vu, T. D., Nguyen, T. T. N., & Nguyen, M. H. (2025). Sustainable management in the hospitality industry: The influence of green human resource management on employees' pro-environmental behavior and environmental performance. *Journal of Hospitality and Tourism Insights*. Advance online publication.

Wang, Y. F., & Chen, S. P. (2020). Application of AHP to evaluate the critical success factors of green hotel. *International Journal of Organizational Innovation, 13*(2), 1–10.