

Article

Eco-Label Implementation Processes and Strategic Management in WB6 Hotels: A PDCA-Based Process Maturity Model for Sustainable Hospitality Operation

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Abstract

Eco-labels can support sustainable tourism, but their credibility depends on more than visible environmental practices. Hotels also need internal processes for planning, implementation, monitoring, review, and continual improvement. This study assessed eco-label process maturity in hotels in the Western Balkans Six region. The analysis included 625 hotels from Serbia, Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, and Montenegro. A 116-item questionnaire was developed and structured according to the Plan-Do-Check-Act cycle. The items were grouped into 14 subcategories and four PDCA phases. The Eco-Label Process Maturity Index was calculated for each hotel. The mean maturity index was 39.76%, and the median value was 32.76%. In total, 59.84% of hotels were classified at Level 1 or Level 2, which indicates non-systematic or basic eco-label-related processes. The DO phase had the highest mean score, while CHECK and ACT had the lowest scores. Certified hotels had significantly higher maturity than non-certified hotels. Larger and higher-category hotels also had higher maturity scores. Differences among WB6 economies were statistically significant, but the effect size was small. PLAN, DO, CHECK, and ACT scores were positively correlated.

Keywords: eco-label; process maturity; resource management; PDCA cycle; environmental management; certification; hospitality management

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1. Introduction

Tourism and hospitality are among the most dynamic service sectors in the global economy, but their post-pandemic recovery has intensified the need for measurable, credible, and process-based sustainability transformation. In 2024, international tourism reached an estimated 1.4 billion international tourist arrivals, corresponding to 99% of the pre-pandemic level and an 11% increase compared with 2023 [1]. In parallel, the World Travel & Tourism Council projected that the total contribution of travel and tourism to the global economy would reach approximately USD 11.1 trillion in 2024, exceeding the previous historical peak and confirming the sector's economic relevance for employment, investment, and regional development [2].

Global tourism receipts were estimated at approximately USD 1.6 trillion in 2024, while international tourism receipts in some emerging destinations increased sharply, including Albania (+136%) and Serbia (+98%), indicating that parts of the Western Balkans are experiencing accelerated tourism growth after the COVID-19 crisis [3].

These trends are economically important, but they also create increasing pressure on hotel systems, local infrastructure, natural resources, waste-management systems, energy supply, water availability, and destination-level environmental quality. At the same time, tourism is a significant contributor to global environmental pressures. Earlier research estimated that tourism accounted for around 8% of global greenhouse gas emissions when direct and supply-chain effects were considered [4]. More recent modelling found that global tourism emissions grew by 3.5% annually between 2009 and 2019, reaching 5.2 Gt CO₂-e in 2019, equivalent to 8.8% of global greenhouse gas emissions [5]. These findings are particularly relevant for hotels because accommodation facilities are process-intensive service organizations. Their environmental performance is not determined by a single activity, but by the interaction of multiple operational processes, including heating, ventilation and air conditioning, lighting, laundry, housekeeping, food and beverage services, procurement, maintenance, waste management, water management, guest communication, and supplier coordination. Isolated green actions or promotional claims are insufficient to improve hotel environmental performance. It requires a structured management approach that connects strategic objectives with measurable operational processes. Eco-labels and sustainability certifications have emerged as important tools for guiding hotels toward more sustainable operations and for communicating credible environmental performance to guests, tour operators, online travel agencies, and public authorities. The EU Ecolabel for tourist accommodation covers hotels, campsites, and other accommodation facilities, and guarantees that certified accommodation has optimized environmental and waste management, reduced energy consumption, reduced water consumption, lower transport-related emissions, and reduced food waste [6]. The number of EU Ecolabel tourist accommodations has grown significantly in recent years. The European Commission reported that holidaymakers had a choice of more than 700 EU Ecolabel hotels and campsites in March 2024 [7]. Subsequent EU tourism transition data indicated that tourist accommodation services reached 778 licences covering 799 services, while the number of licences had doubled from 392 in September 2020 to 778 in the reported period [8]. The broader certification market is also expanding. Green Key, one of the most recognized global sustainability certification schemes for tourism establishments, reports more than 9000 certified hotels and other establishments in more than 90 countries [9]. These figures show that third-party environmental certification is no longer marginal; it is becoming an increasingly visible instrument of sustainable tourism competitiveness. However, the expansion of eco-labels also creates new research and management challenges. First, certification does not automatically mean deep organizational transformation. Some hotels may obtain or pursue certification as a marketing signal without fully embedding sustainability into everyday processes. Second, certification schemes differ in scope, indicators, audit requirements, and level of transparency. Third, small- and medium-sized hotels often face barriers such as limited financial resources, limited technical expertise, insufficient environmental data, lack of employee training, weak supplier engagement, and low managerial awareness of long-term benefits. Fourth, consumer trust in sustainability claims is increasingly fragile. A European Commission study found that 53.3% of examined environmental claims in the EU were vague, misleading, or unfounded, while 40% were unsubstantiated [10]. This indicates that eco-label implementation must be supported by measurable evidence, documented procedures, internal audits, performance indicators, and continual improvement mechanisms. In the hotel sector, this means that eco-label readiness is evaluated not only by the existence of environmental practices, but by the maturity

of the processes that plan, implement, monitor, and improve those practices. In this paper, eco-label process maturity refers to the extent to which a hotel has established the internal management processes needed to support credible eco-label certification. These processes include planning, implementation, monitoring, review, and continual improvement. This concept is different from certification status. Certification status indicates whether a hotel already has a relevant certificate or management-system standard. Eco-label readiness refers to the hotel's preparedness to meet eco-label requirements, while eco-label implementation refers to the practical application of eco-label-related processes. Consumer-side evidence confirms that certification and credible sustainability information are becoming important market signals. Booking.com's 2024 Sustainable Travel Report, based on more than 31,000 travelers across 34 countries and territories, found that 75% of global travelers wanted to travel more sustainably over the following 12 months [11]. The same research indicated that accommodation labelled as more sustainable was more appealing to 45% of travelers, while 67% agreed that all travel booking sites use the same sustainable certifications or labels [12]. In 2025, Booking.com reported that, after surveying nearly 230,000 travelers across 35 markets since 2016, 93% of global travelers said they wanted to make more sustainable travel choices and had done so to some extent [13]. These data suggest that sustainability certification can influence competitiveness, but they also highlight the need for credible, comparable, and verifiable certification systems. For hotels, this creates a strategic management problem: how to transform sustainability from a marketing-oriented claim into a structured process-management system that can be measured, audited, improved, and aligned with long-term business development. The Western Balkans Six region, consisting of Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia, represents a particularly relevant context for studying hotel eco-label implementation processes. The region is geographically close to the European Union, being increasingly integrated into European tourism flows, and institutionally connected to the EU Green Agenda for the Western Balkans. The Green Agenda for the Western Balkans, endorsed through the Sofia Declaration and aligned with the European Green Deal, identifies climate action, circular economy, depollution, sustainable food systems, biodiversity protection, clean energy, sustainable transport, and private sector development as priority areas [14]. The European Commission has committed EUR 1.25 billion since 2021 to support the implementation of the Green Agenda, including technical assistance and investments in energy efficiency, renewable energy, coal transition, and environmental management [14]. Within this context, hotels are not only tourism businesses; they are service-sector organizations whose resource consumption, procurement choices, waste management, and guest communication processes directly contribute to the region's green transition. Despite this policy relevance, the Western Balkans hotel sector faces structural challenges that can slow eco-label adoption. Many hotels in the region are micro, small, or family-owned enterprises with limited managerial capacity, limited access to green finance, and insufficient experience with formal management systems. Previous research on hotels in Serbia showed that the implementation of a PDCA-based emergency planning and disaster recovery management model was relatively low, with an average implementation level of 35.80%; the Plan phase reached 34.51%, the Do phase reached 40.85%, the Check phase reached 30.46%, and the Act phase only reached 22.71% [15]. The same study found that hotels with certified quality management systems had a significantly higher implementation level of management-system requirements than hotels without certified systems, and that larger and higher-category hotels showed higher levels of implementation [15]. These findings are important for the present research because they suggest that hotel size, category, existing certification culture, and process-management capacity may also influence eco-label readiness and environmental process maturity. A related paper on sustainable development in hotels within the WB6 region also

emphasized the relevance of management systems and structured energy-management practices for hotel sustainability [16]. The literature on sustainability certification in hospitality has expanded considerably, but several gaps remain. Studies have examined the role of environmental certification in hotel competitiveness, consumer preferences, guest ratings, willingness to pay, and sustainability communication. For example, Nelson et al. [17] surveyed 535 tourists and found that, across price premiums ranging from USD 0.75 to USD 7.50 per night, more than 50% of tourists were willing to pay extra for a local green hotel certification, with a lower-bound mean willingness to pay of USD 1.55 per night. Kang et al. [18] showed that consumers' willingness to pay for hotel green initiatives varies according to environmental attitudes and hotel segment. Peiró-Signes et al. [19] found that environmental certification can influence hotel guest ratings. Molina-Azorín et al. [20] demonstrated that quality and environmental management can contribute to competitive advantage in hotels. More recent research has highlighted that management environmental concern can influence green process innovation and green product innovation, which in turn affect hotel green performance [21]. Rodríguez-García et al. [22] analyzed sustainability certifications adopted by large hotel companies and found that the environmental dimension was present in 100% of the analyzed certifications, while only 75% also covered social and economic aspects, indicating that certification schemes still vary in their level of holistic sustainability integration. Existing sustainability assessment systems in hospitality can be grouped into several broad categories. First, certification and eco-label schemes, such as the EU Ecolabel, Green Key, and GSTC-recognized standards, define criteria that hotels must satisfy to demonstrate environmental or sustainability performance [23–27]. These schemes are important for market credibility and verification, but they usually function as compliance or certification frameworks. Second, environmental management system approaches, especially ISO 14001-based models, emphasize structured planning, operational control, monitoring, documentation, audit, and continual improvement [28–32]. Third, green hotel assessment and grading systems evaluate visible environmental practices, infrastructure, resource efficiency, green attributes, guest-related sustainability measures, and the contribution of hotel practices to sustainable development goals [33–36]. Fourth, maturity models in environmental management and sustainability usually classify organizations into staged levels of development and describe the progression from fragmented practices to systematic and continuously improving management [37–41]. However, these approaches are rarely combined into a single quantitative hotel-level index that evaluates eco-label readiness through PDCA-based internal process maturity. The proposed model differs from previous approaches because it does not only assess the existence of environmental practices, certification status, or general sustainability criteria. It measures the maturity of the internal processes that support credible eco-label implementation, including planning, operational application, monitoring, review, corrective action, and continual improvement.

Additional empirical and review studies further support this positioning. Research on voluntary environmental tools in hotels shows that eco-labels, environmental management systems, best environmental practices, and environmental performance indicators are adopted unevenly and are influenced by managerial perceptions, organizational capacity, and stakeholder pressure [42]. Studies on hotel environmental management practices also show that hotel category, managerial awareness, formal environmental policies, conservation practices, and operational procedures influence the level of environmental implementation [43–46]. Green hotel studies confirm that environmental practices usually concentrate on energy, water, waste, guest rooms, procurement, and operational efficiency, while more advanced practices require stronger management commitment and systematic control [47,48]. Broader sustainability maturity research also supports the use of staged models for assessing the development of sustainability capabilities, especially in

small- and medium-sized enterprises [49,50]. Recent hotel sustainability research further emphasizes the importance of internal drivers, barriers, communication, training, green supply chain management, and structured managerial support for implementing sustainability strategies [51,52]

Nevertheless, much of the existing literature remains focused on certification outcomes, consumer behavior, willingness to pay, visible green practices, voluntary environmental tools, or broad sustainability criteria [23–25,42–48]. Less attention has been paid to the internal process maturity through which hotels become ready for eco-label implementation. This is a critical gap because eco-label adoption requires more than the formal fulfilment of criteria. It requires a sequence of managerial and operational processes: defining sustainability policy, identifying environmental aspects, setting measurable objectives, assigning responsibilities, training employees, applying operational controls, documenting evidence, monitoring resource consumption, conducting audits, communicating with stakeholders, correcting deviations, and continuously improving performance. In other words, eco-label readiness is fundamentally a process-management problem. This makes it highly relevant for industrial management and strategic management because it connects operational efficiency, organizational learning, environmental performance, stakeholder trust, and long-term competitive positioning. The Plan–Do–Check–Act cycle provides a suitable theoretical and methodological basis for evaluating eco-label implementation processes. ISO 14001 defines environmental management systems as structured frameworks that help organizations manage environmental impacts, comply with legal requirements, prevent pollution, and improve environmental performance over time [53]. The PDCA logic is also widely used in environmental management systems, where organizations first commit to an environmental policy, then establish objectives and plans, implement procedures, evaluate results, and improve the system through corrective and preventive actions [54]. Applying the PDCA cycle to eco-label implementation enables researchers to move beyond binary certification status and examine the maturity of the processes that support certification readiness. It also allows for the identification of weak phases. For example, hotels may implement operational eco-practices such as LED lighting or towel-reuse programs, but still lack systematic monitoring, internal audits, documented evidence, corrective actions, and strategic renewal. Such a situation would indicate operational activity without full process maturity. Based on these considerations, this study proposes and tests a PDCA-based Eco-Label Process Maturity Model for hotels in the WB6 region. The model organizes eco-label implementation into fourteen subcategories adapted from management-system logic: system approach; leadership; environmental and eco-label policy; planning for eco-label implementation; legal, standard, and eco-label requirements; eco-label objectives and action plans; application of defined plans; employee involvement; communication; documentation system; process approach; eco-design and infrastructure; monitoring and fact-based decision-making; and system review and continual improvement. These subcategories correspond to the four PDCA phases and allow for the calculation of both phase-level and overall maturity scores. The proposed model is designed to evaluate whether hotels have only fragmented environmental activities or whether they have a structured, documented, measurable, and continuously improving eco-label implementation system. The main aim of this study is to develop and apply a PDCA-based process maturity model for assessing eco-label readiness and sustainability management in WB6 hotels. More specifically, the study aims to: (1) assess the level of eco-label process maturity among hotels in the Western Balkans; (2) examine differences in maturity according to certification status, hotel size, hotel category, and WB6 economy; (3) identify the weakest PDCA phases and subcategories in eco-label implementation; and (4) provide managerial and policy insights for improving hotel sustainability processes in the WB6 region. Facility-related differences are examined as a supplementary

analysis because they indicate operational complexity, but they are not treated as formal research hypotheses. The principal contribution of this study is not the development of a new theory of PDCA or maturity modelling, because these concepts are already well established. Rather, the contribution is the adaptation and empirical application of a PDCA-based Eco-Label Process Maturity Index for assessing hotel-level eco-label readiness in the WB6 region. The model integrates eco-label readiness, internal process maturity, strategic management, industrial management, and operational sustainability into a single diagnostic framework. In comparison with existing certification-oriented and practice-oriented assessment systems, the proposed model provides an item-based maturity index that identifies where the PDCA cycle is weak and allows for comparisons across hotels, hotel categories, hotel sizes, certification groups, and WB6 economies. The framework responds to the need for credible, measurable, and comparable sustainability tools for hospitality. It also provides a practical diagnostic model for hotel managers, certification bodies, tourism policymakers, and regional development institutions. The remainder of the paper is organized as follows. Section 2 presents the materials and methods, including the research design, sample structure, questionnaire development, PDCA-based variables, scoring procedure, and statistical tests. Section 3 presents the results, including descriptive statistics, reliability analysis, maturity-level distribution, PDCA phase scores, subcategory scores, and differences among hotel groups. Section 4 discusses the findings in relation to eco-label implementation, sustainability management, and hotel process maturity. Section 5 presents the conclusions, limitations, and directions for future research.

2. Materials and Methods

This study used a quantitative and comparative research design. The unit of analysis was the hotel. The study examined eco-label implementation processes in hotels in the Western Balkans Six region. The region included Serbia, Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, and Montenegro. The research measured eco-label process maturity. It did not only examine whether a hotel had an eco-label or an environmental certificate. It examined whether the hotel had the internal management processes needed to plan, implement, monitor, and improve eco-label-related activities.

The research model was structured according to the Plan–Do–Check–Act cycle. The PDCA logic was used because eco-label implementation is a continuous process. It requires planning, operational application, monitoring, review, and improvement (Figure 1). The PDCA approach is also suitable for hotel management-system analysis because it links strategic decisions with operational processes and measurable outcomes. The study developed an Eco-Label Process Maturity Index. This index was used to assess the level of eco-label implementation maturity in each hotel. The index also allowed for comparisons among countries, hotel categories, hotel sizes, certification groups, and facility groups.

The study examined the relationship between hotel characteristics and eco-label process maturity. The hypotheses were formulated to test whether eco-label maturity is associated with certification status, hotel size, hotel category, territorial context, and the internal logic of the PDCA cycle.

RH1: Certified hotels have a higher Eco-Label Process Maturity Index than non-certified hotels.

RH2: Larger hotels have a higher Eco-Label Process Maturity Index than micro and small hotels.

RH3: Higher-category hotels have a higher Eco-Label Process Maturity Index than lower-category hotels.

RH4: Eco-label process maturity differs significantly among WB6 economies.

RH5: PLAN-phase maturity is positively related to DO-phase, CHECK-phase, and ACT-phase maturity.

The analysis covered hotels and similar accommodation facilities in the WB6 region. The database included 625 accommodation facilities. These facilities were in Serbia, Albania, Bosnia and Herzegovina, Kosovo, North Macedonia, and Montenegro. The sample included city hotels, coastal hotels, mountain hotels, spa hotels, wellness hotels, business hotels, conference hotels, boutique hotels, resorts, apart-hotels, and motels. This structure was important because the hospitality sector in the Western Balkans is heterogeneous. Hotels differ in size, category, market position, service complexity, and level of formal management system implementation. The distribution of the sample by economy is presented in Table 1. The sample was suitable for regional comparison. It included all six WB6 economies. It also included hotels with different levels of development. This reduced the risk that the results would describe only one national hotel market or only one type of accommodation facility.

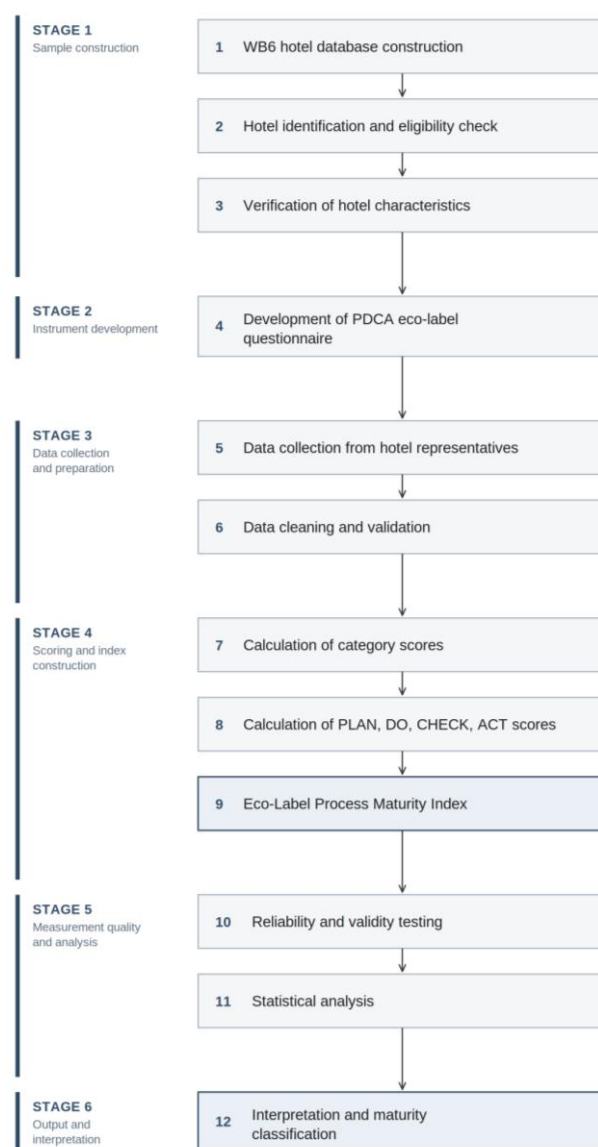


Figure 1. Research methodology flowchart for assessing eco-label process maturity in WB6 hotels.

Table 1. Distribution of the hotel sample analyzed across the WB6 region.

WB6	Number of Hotels	Share of Total Sample
Albania	87	13.92%
Bosnia and Herzegovina	113	18.08%
Kosovo	72	11.52%
North Macedonia	83	13.28%
Montenegro	116	18.56%
Serbia	154	24.64%

Note: The sample included hotels and hotel-type accommodation facilities, such as hotels, motels, resorts, aparthotels, spa hotels, wellness hotels, business hotels, conference hotels, and boutique hotels. Hostels without hotel-type services and private apartments were excluded according to the inclusion criteria.

The inclusion criteria were defined before data processing. A facility was included if it was operated as a hotel, motel, resort, aparthotel, spa hotel, boutique hotel, conference hotel, or similar accommodation facility. The facility also had to be located in one of the six WB6 economies. It had to have an identifiable name and location. It also had to have enough available data for classification by country, category, size, facilities, and certification status. Facilities were excluded if they were private apartments, hostels without hotel-type services, informal accommodation units, duplicated records, or facilities without enough information for classification. Duplicate entries were checked manually. Hotels with the same name and address were treated as one unit. Chain hotels were treated as separate units only when they operated at different locations.

The hotel database was created from structured WB6 hotel datasets and publicly available hotel information. Public sources were used to verify hotel name, location, category, facilities, and visible certification status. These sources included hotel websites, accommodation platforms, tourism portals, and public hotel directories. The empirical analysis was based on hotel-level responses. Hotel managers or responsible hotel representatives completed the questionnaire. Suitable respondents included general managers, quality managers, sustainability managers, and operations managers. A substantial number of questionnaires were also collected through telephone interviews. The study did not use a probabilistic sampling frame based on a complete official register of all accommodation facilities in the WB6 region. Instead, the sample was developed from structured WB6 hotel datasets, publicly available hotel information, and hotel-level responses. For this reason, a conventional response rate and refusal rate could not be calculated in the same way as in a closed sampling frame survey. This should be considered when interpreting representativeness. The results describe the analyzed sample and should not be interpreted as a census of the entire WB6 hotel sector.

The first part of the research database included hotel profile variables. These variables were used to describe the sample and to test differences among hotel groups. The profile variables included country; hotel name; address; hotel category; guest rating where available; hotel size; years on the market; pool, spa or wellness facilities; fitness facilities; congress or conference facilities; ISO standards; HACCP-related standards; and certification status. Hotel size was classified into four groups: micro, small, medium-sized, and large hotels. Years on the market were classified into four development stages: existence, survival, success, and maturity. Certification status was classified as certified or non-certified. A hotel was treated as certified if it reported or publicly showed at least one relevant management system, environmental, quality, food-safety, or similar standard (Figure 2). The certified category was therefore used as an indicator of general certification culture and formal management-system experience. It did not distinguish between environmental-specific certifications, such as ISO 14001, EU Ecolabel, or Green Key, and other

management or operational standards, such as ISO 9001 or HACCP. This aggregation may obscure differences among certification types and should be considered when interpreting the relationship between certification status and eco-label process maturity.

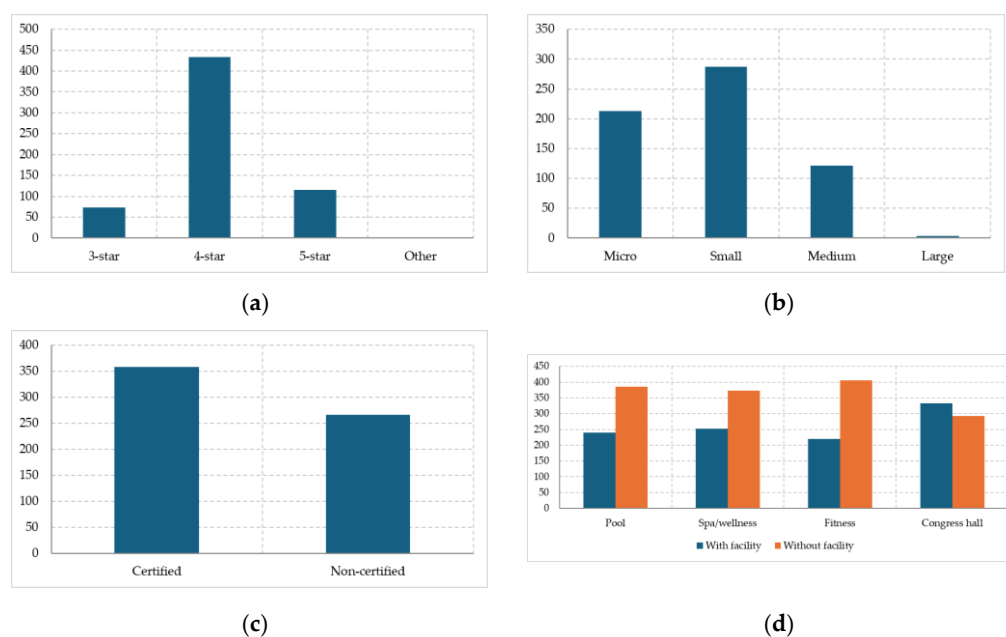


Figure 2. Structure of the WB6 hotel sample according to category, size, certification status, and facilities. Panel (a) shows the distribution by hotel category. Panel (b) shows the distribution by hotel size. Panel (c) shows the distribution by certification status. Panel (d) shows the distribution by pool, spa/wellness, fitness, and congress facilities.

Figure 2 shows that the WB6 hotel sample was dominated by four-star hotels. In total, 433 hotels were classified as four-star facilities, which represented 69.28% of the sample. A total of 116 facilities, or 18.56%, were classified as five-star hotels and 74 facilities, or 11.84%, were classified as three-star hotels. Only two facilities, or 0.32%, were classified in the “other” category. The sample was also dominated by small and micro hotels. Small hotels represented the largest group, with 287 facilities, or 45.92%. Micro hotels followed with 213 facilities, or 34.08%. A total of 121 facilities, or 19.36%, were medium-sized hotels. Large hotels were rare, with only four facilities, or 0.64%. More than half of the hotels had at least one reported certification. A total of 359 facilities, or 57.44%, were certified hotels, while 266 hotels, or 42.56%, were non-certified. The sample also included hotels with different service facilities. A pool was present in 240 hotels, or 38.40%. Spa or wellness facilities were present in 252 hotels, or 40.32%. Fitness facilities were present in 220 hotels, or 35.20%. Congress halls were present in 333 hotels, or 53.28%. These results confirm that the sample included hotels with different categories, sizes, certification profiles, and operational complexity. However, the sample structure should be interpreted carefully. Four-star and five-star hotels were strongly represented in the sample, while three-star hotels and lower-category accommodation facilities were less represented. Since higher-category hotels had higher maturity scores, this composition may increase the overall mean Eco-Label Process Maturity Index. Therefore, the results should be interpreted as an assessment of the analyzed hotel sample rather than as a full census of all accommodation facilities in the WB6 region.

The questionnaire structure was developed based on empirical and review literature on voluntary environmental tools in hotels, hotel environmental management practices, green hotel operations, sustainability maturity models, corporate sustainability implementation, and green supply chain management in hotels [42–51].

The questionnaire was developed through a structured conceptual mapping procedure. First, the PDCA cycle was used as the main organizing logic because eco-label implementation requires planning, operational application, monitoring, review, and continual improvement. Second, the subcategories were derived from environmental management system logic, hotel sustainability assessment literature, and the requirements commonly found in eco-label and sustainability certification schemes. Third, the items were formulated to reflect observable hotel-level practices rather than personal attitudes. This was important because the unit of analysis was the hotel, not the individual respondent. Fourth, the items were grouped into 14 subcategories in order to cover strategic, operational, documentary, monitoring, and improvement-related aspects of eco-label readiness. The wording of the items was reviewed by the authors to improve clarity and avoid duplication before data collection.

The second part of the research instrument measured eco-label implementation processes. The questionnaire included 116 questions, which are provided in Supplementary Table S1. The questions were grouped into 14 subcategories. The subcategories were organized according to the PDCA cycle (Figure 3). The PLAN phase included six subcategories. These were system approaches, leadership, environmental and eco-label policy, eco-label planning, legal, standard and eco-label requirements, and objectives, targets and action plans. The DO phase included six subcategories. These were applications of defined plans, employee involvement and training, communication, documentation system, process approach, and eco-design and infrastructure. The CHECK phase included one broad subcategory: monitoring, measurement, and fact-based decision-making. The ACT phase also included one broad subcategory: system review, corrective actions, and continual improvement. These two subcategories were measured through several questionnaire items, but they were treated as one subcategory each in the PDCA model. The structure of the questionnaire allowed assessment at several levels. It allowed for item-level analysis, category-level analysis, PDCA-phase analysis, hotel-level analysis, country-level analysis, and WB6-level analysis. The content validity of the instrument was therefore supported by the explicit mapping of questionnaire items to PDCA phases, environmental management principles, and eco-label-related hotel practices. However, an independent external expert-panel validation was not conducted, and this is acknowledged as a limitation of the study.

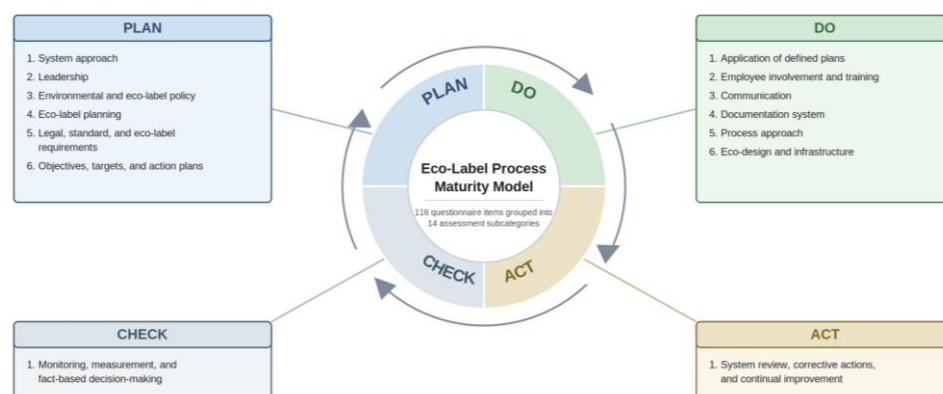


Figure 3. PDCA-based eco-label process maturity model with 14 assessment subcategories. PLAN and DO include six subcategories each, while CHECK and ACT include one broad subcategory each, measured through several questionnaire items.

Each questionnaire item was scored on a three-level ordinal scale. A value of 0 indicated “No” or “not implemented”. A value of 1 indicated “Partially implemented”. A value of 2 indicated “Yes” or “fully implemented”. The Eco-Label Process Maturity Index

was calculated as the total achieved score across all 116 items divided by the maximum possible score of 232 and multiplied by 100. Therefore, the index ranged from 0% to 100%. This item-weighted index was used as the primary maturity measure. The five maturity levels were defined using equal 20-point intervals on the 0–100% index scale. This classification was selected because it provides a transparent and easily interpretable structure for distinguishing non-systematic, basic, partial, advanced, and fully developed eco-label process maturity. The thresholds were not intended to represent official certification cut-off points. They were used as analytical categories for comparing hotels and identifying broad maturity patterns. Further validation of these thresholds through expert panels, certification bodies, and longitudinal studies would strengthen future applications of the model. Hotels were then classified into five non-overlapping maturity levels: Level 1, 0.00–20.00%; Level 2, 20.01–40.00%; Level 3, 40.01–60.00%; Level 4, 60.01–80.00%; and Level 5, 80.01–100.00%. The index used equal weighting for all 116 questionnaire items. This approach was selected to keep the scoring transparent, reproducible, and easy to apply by hotel managers and policymakers. However, equal weighting assumes that each practice contributes equally to eco-label readiness. This is a methodological limitation. Some items may represent basic requirements, while others may represent more advanced management capabilities. In addition, the number of items differed across PDCA phases. The DO phase included more items than the CHECK and ACT phases, which means that the overall item-weighted index may be more influenced by operational implementation than by monitoring and improvement. For this reason, phase-level scores were also reported separately.

Descriptive statistics were used to present the sample and maturity scores. Frequencies and percentages were used for categorical variables. Mean, median, standard deviation, minimum, maximum, and quartiles were calculated for maturity scores. Cronbach's alpha was used to assess internal consistency. The Mann–Whitney U test was used for two-group comparisons. The Kruskal–Wallis test was used for comparisons among three or more groups. Dunn–Bonferroni post-hoc comparisons were used when Kruskal–Wallis tests were significant. The Friedman test was used to compare repeated PDCA phase scores within the same hotels. Bonferroni-adjusted Wilcoxon signed-rank tests were used for pairwise PDCA phase comparisons. Spearman correlation analysis was used to examine relationships between PLAN, DO, CHECK, and ACT scores. Statistical significance was assessed at $p < 0.05$.

The study used organizational data. The respondents answered on behalf of the hotel. Participation was voluntary. Respondents were informed about the purpose of the research and the scientific use of the data. Hotel names were used for database construction and internal coding. The results were reported in aggregated form. Individual hotel results were not disclosed unless permission was given. No sensitive personal data were collected. Because the empirical data included hotel-level responses provided by managers or responsible hotel representatives, self-report bias and social desirability bias cannot be fully excluded. Respondents may have overestimated the implementation of some environmental or management practices. This risk was reduced by formulating items around observable hotel-level processes, documentation, monitoring, and procedures rather than personal attitudes. Nevertheless, the possibility of overstatement should be considered when interpreting the results.

GenAI tools were used only for superficial language editing, including spelling, grammar, punctuation, and minor wording corrections. Figure 3 was prepared by the authors, and AI support related to this figure was limited to improving the clarity.

3. Results

3.1. Eco-Label Process Maturity in WB6 Hotels

We calculated the Eco-Label Process Maturity Index for 625 hotels in the WB6 region. The index ranged from 0.00% to 100.00%. The mean value was 39.76%. The median value was 32.76%. The standard deviation was 28.77 percentage points. The first quartile was 19.40%, and the third quartile was 59.91%. These values show high variation in eco-label process maturity among hotels. The distribution of the index is shown in Figure 4. The histogram was prepared using 10 percentage-point intervals. The figure also shows vertical threshold lines at 20%, 40%, 60%, and 80%. These thresholds separate the five maturity levels. The distribution was not symmetric. Many hotels were concentrated in the lower and medium-low maturity intervals. This indicates that eco-label implementation is still weak or only partly developed in a large part of the WB6 hotel sector.

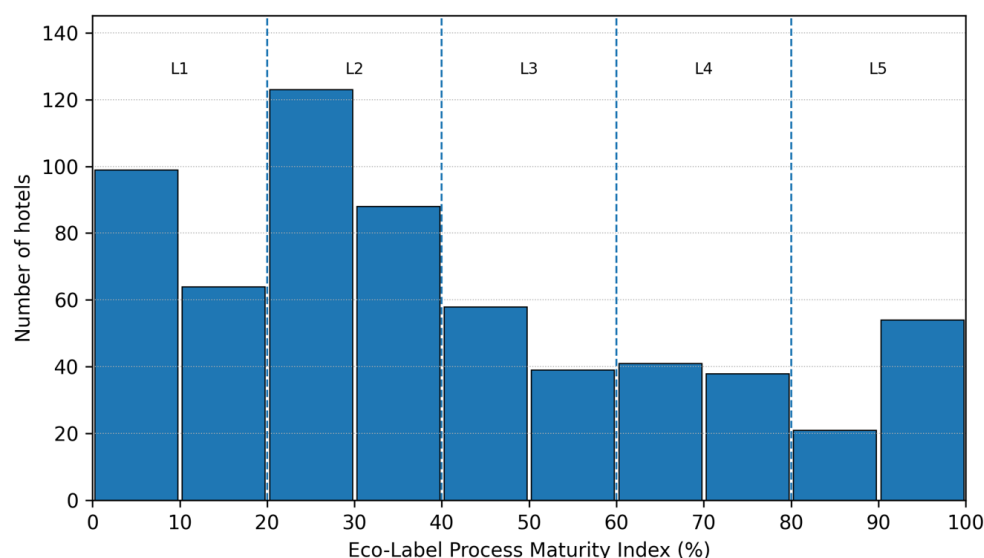


Figure 4. Distribution of the Eco-Label Process Maturity Index across WB6 hotels. Vertical lines indicate the maturity-level thresholds at 20%, 40%, 60%, and 80%.

The histogram shows that 99 hotels, or 15.84%, were in the 0–10% interval. A further 64 hotels, or 10.24%, were in the >10–20% interval. This means that 163 hotels, or 26.08%, were below or equal to 20% maturity. These hotels had non-systematic eco-label processes. The largest maturity group was Level 2. It included 211 hotels, or 33.76%, with scores above 20% and up to 40%. These hotels had basic environmental awareness, but their eco-label processes were not yet fully structured. Together, Level 1 and Level 2 included 374 hotels, or 59.84% of the sample. This shows that most hotels were below 40% maturity. Level 3 included 97 hotels, or 15.52%. These hotels showed partial eco-label readiness. Level 4 included 79 hotels, or 12.64%. These hotels had advanced eco-label process maturity. Level 5 included 75 hotels, or 12.00%. These hotels had a fully developed or nearly fully developed eco-label implementation system (Table 2). The group-comparison tests identify associations between hotel characteristics and eco-label process maturity. They do not estimate independent causal effects because hotel characteristics such as size, category, certification status, facilities, and country context may be interrelated.

Table 2. Distribution of hotels by eco-label maturity level.

Maturity Level	Score Range	Number of Hotels	Share
Level 1	0.00–20.00%	163	26.08%
Level 2	20.01–40.00%	211	33.76%

Level 3	40.01–60.00%	97	15.52%
Level 4	60.01–80.00%	79	12.64%
Level 5	80.01–100.00%	75	12.0%

These results show that eco-label process maturity is unevenly distributed across the WB6 hotel sector. A smaller group of hotels reached high maturity levels. However, the majority of hotels remained in the non-systematic or basic-awareness stages. This suggests that many hotels still need stronger planning, documentation, monitoring, review, and continual improvement before they can be considered fully prepared for credible eco-label implementation.

3.2. Implementation of the PDCA Phases

The four PDCA phases had different implementation levels. The DO phase had the highest mean score, with 47.81%. The PLAN phase followed with 38.42%. The CHECK phase had a lower mean score, with 29.31%. The ACT phase had the lowest mean score, with 25.06%. These results show that hotels more often apply operational environmental practices than systematic monitoring and improvement (Figure 5). This is important for eco-label implementation. Eco-label readiness cannot be based only on visible operational activities. It also requires planning, measurement, review, corrective actions, and continual improvement.

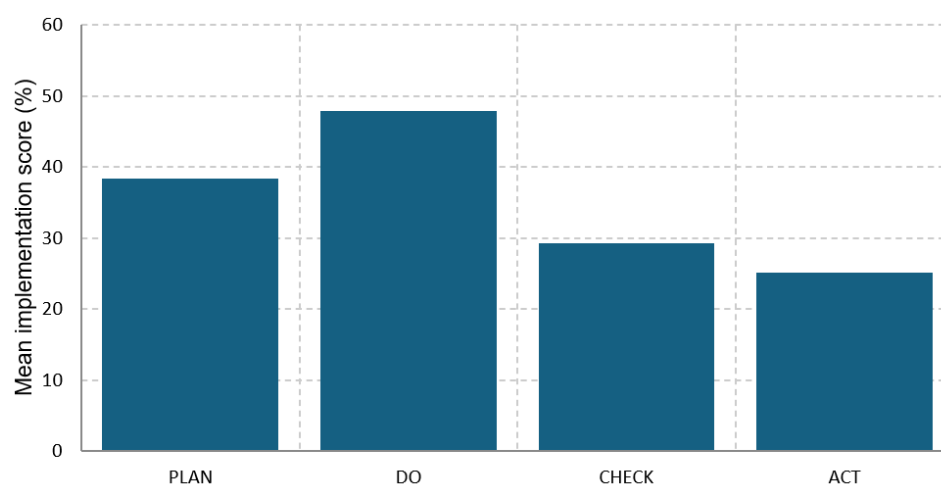


Figure 5. Mean implementation scores for PLAN, DO, CHECK, and ACT phases.

The median values confirmed the same pattern. The median DO score was 49.00%. The median PLAN score was 34.21%. The median CHECK score was 17.86%. The median ACT score was 14.29%. This shows that monitoring and improvement were weak in many hotels (Table 3).

Table 3. Descriptive statistics for PDCA phase scores and the overall Eco-Label Process Maturity Index.

Variable	Mean [%]	Median [%]	Standard Deviation	Minimum [%]	Maximum [%]
PLAN	38.42	34.21	30.32	0.0	100.0
DO	47.81	49.0	29.76	0.0	100.0
CHECK	29.31	17.86	31.30	0.0	100.0
ACT	25.06	14.29	29.90	0.0	100.0
Index	39.76	32.76	28.77	0.0	100.0

We used the Friedman test because the four PDCA phase scores were repeated measurements for the same 625 hotels. The test confirmed a statistically significant difference among the four PDCA phases ($\chi^2(3) = 1087.79$, $p < 0.001$). Kendall's W was 0.580, which indicates a large overall effect. Bonferroni-adjusted pairwise Wilcoxon signed-rank tests confirmed that CHECK and ACT scores were significantly lower than PLAN and DO scores, with all adjusted p -values below 0.001.

The analysis of the 14 PDCA subcategories gave a more detailed picture of eco-label process maturity. The highest mean scores were found in the DO phase. Category 7, application of defined plans, had the highest mean score, with 50.72%. Category 12, eco-design and infrastructure, followed with 50.45%. Category 11, process approach, had a mean score of 48.20%. The weakest scores were found in the CHECK and ACT phases. Category 14, system review and continual improvement, had the lowest mean score, with 25.06%. Category 13, monitoring and fact-based decision-making, had a mean score of 29.31%. Low values were also found for Category 6 (objectives, targets, and action plans), with 31.97%, and Category 4 (eco-label planning), with 32.16% (Figure 6).

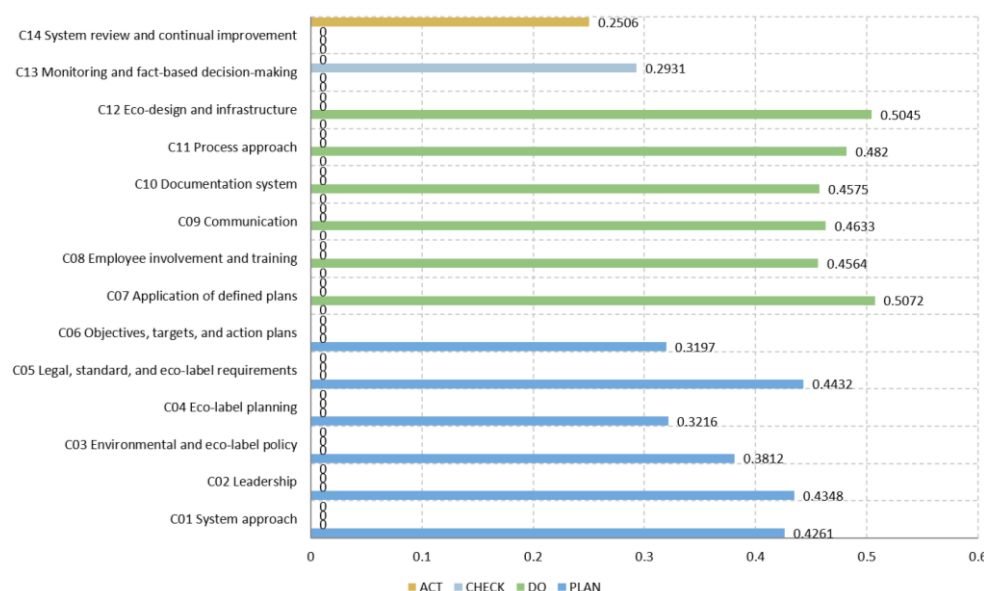


Figure 6. Mean implementation scores of the 14 PDCA eco-label subcategories.

These results show that many hotels apply selected environmental practices, but they do not yet manage them as a complete eco-label process. The main weaknesses are measurable objectives, structured eco-label planning, monitoring, internal review, corrective actions, and continual improvement.

3.3. Eco-Label Process Maturity by WB6

3.3.1. Eco-Label Process Maturity by WB6 Economy

The Eco-label process maturity index differed among the six WB6 economies. Serbia had the highest mean score, with 50.64%. Montenegro followed with 39.66%. North Macedonia had a mean score of 36.38%. Albania had a mean score of 35.59%. Bosnia and Herzegovina had a mean score of 34.34%. Kosovo had the lowest mean score, with 34.07% (Table 4).

The Kruskal–Wallis test showed that the differences among WB6 economies were statistically significant ($H = 24.35$, $p < 0.001$). The effect size was small, with $\varepsilon^2 = 0.031$. This indicates that WB6 economy differences explained only a limited share of variation in eco-label process maturity. RH4 received limited support and should be interpreted

cautiously. Country context was statistically relevant, but hotel-level factors such as certification status, size, and category appeared more important.

Table 4. Mean PDCA phase scores by WB6 economy.

WB6	PLAN	DO	CHECK	ACT	Index
Albania	30.85%	48.17%	20.98%	18.10%	35.59%
Bosnia and Herzegovina	30.26%	48.29%	16.59%	13.31%	34.34%
Kosovo	35.25%	36.13%	30.56%	27.03%	34.07%
North Macedonia	37.71%	38.45%	32.62%	29.13%	36.38%
Montenegro	43.40%	40.98%	35.22%	29.25%	39.66%
Serbia	46.79%	62.92%	36.53%	31.35%	50.64%

The results show that CHECK and ACT were weaker than PLAN and DO in all six economies. This means that the main regional weakness was not only the lack of environmental actions. The main weakness was the lack of systematic monitoring, review, and improvement.

3.3.2. Eco-Label Process Maturity by Certification Status

The Mann–Whitney U test confirmed a statistically significant difference between certified and non-certified hotels. Certified hotels had a higher Eco-Label Process Maturity Index than non-certified hotels. The mean score for certified hotels was 56.41%, and the median score was 53.02%. The mean score for non-certified hotels was 17.28%, and the median score was 17.89%. The difference was statistically significant ($U = 88,031.00$, $p < 0.001$). The rank-biserial correlation was 0.844, which indicates a strong effect. Therefore, RH1 was supported. This result means that general certification culture and prior experience with formal management-system requirements are strongly associated with eco-label process maturity. However, because the certified group included different certification types, the result should not be interpreted as the isolated effect of environmental certification alone. Hotels that already use formal management systems appear to be better prepared for eco-label implementation.

3.3.3. Eco-Label Process Maturity by Hotel Category and Hotel Size

Hotel category was strongly associated with eco-label process maturity. Five-star hotels had the highest mean score, with 67.01%, and a median score of 71.55%. Four-star hotels had a mean score of 37.36% and a median score of 32.76%. Three-star hotels had the lowest mean score, with 11.37%, and a median score of 11.42%. The two hotels in the “other” category had a mean and median score of 28.66%. The Kruskal–Wallis test showed a statistically significant difference among hotel categories ($H = 176.36$, $p < 0.001$). The effect size was $\epsilon^2 = 0.279$, which indicates a strong practical effect. Therefore, RH3 was supported.

Hotel size was also strongly associated with eco-label process maturity. Large hotels had the highest mean score, with 98.17%, and a median score of 100.00%. Medium-sized hotels had a mean score of 74.48% and a median score of 77.59%. Small hotels had a mean score of 38.81% and a median score of 35.34%. Micro hotels had the lowest mean score, with 20.21%, and a median score of 18.10%. The Kruskal–Wallis test showed a statistically significant difference among hotel-size groups ($H = 283.43$, $p < 0.001$). The effect size was $\epsilon^2 = 0.452$, which indicates a very strong practical effect. Therefore, RH2 was supported. These results show that eco-label maturity is strongly associated with organizational capacity. Larger and higher-category hotels are more likely to have formal procedures, trained staff, documentation, monitoring, and internal review. However, these results should be interpreted as associations rather than independent effects. Hotel size, hotel

category, certification status, facilities, and country context may be interrelated. Therefore, the group-comparison tests do not show whether each characteristic independently predicts eco-label process maturity after controlling for the others.

3.3.4. Supplementary Facility Analysis

Hotels with additional service facilities had higher eco-label process maturity than hotels without such facilities. Hotels with a pool had a mean score of 56.31% and a median score of 55.82%. Hotels without a pool had a mean score of 29.44% and a median score of 26.29%. The Mann–Whitney U test showed a significant difference ($U = 70,646.50$, $p < 0.001$). The rank-biserial correlation was 0.529, which indicates a moderate-to-strong effect. Hotels with spa or wellness facilities had a mean score of 60.51% and a median score of 60.78%. Hotels without spa or wellness facilities had a mean score of 25.73% and a median score of 25.43%. The difference was statistically significant ($U = 78,880.00$, $p < 0.001$). The rank-biserial correlation was 0.678, which indicates a strong effect. Hotels with fitness facilities had a mean score of 63.96% and a median score of 62.50%. Hotels without fitness facilities had a mean score of 26.61% and a median score of 25.86%. The difference was statistically significant ($U = 77,032.00$, $p < 0.001$). The rank-biserial correlation was 0.729, which indicates a strong effect. Hotels with congress or conference facilities had a mean score of 51.67% and a median score of 43.97%. Hotels without congress or conference facilities had a mean score of 26.18% and a median score of 22.63%. The difference was statistically significant ($U = 75,838.50$, $p < 0.001$). The rank-biserial correlation was 0.560, which indicates a moderate-to-strong effect. Operational complexity was associated with higher eco-label maturity. Hotels with more facilities usually consume more energy and water. They also generate more waste and require more formalized processes. This may explain why these hotels are more likely to develop structured sustainability procedures. These results were treated as supplementary findings and were not used for formal hypothesis testing.

However, these findings should be interpreted carefully. The cross-sectional design does not allow for causal inference. The association between facility availability and eco-label process maturity may reflect reverse causality because hotels with more developed management systems may be more likely to invest in additional facilities. It may also reflect common underlying factors, such as hotel size, category, capital availability, and managerial capacity. Therefore, these supplementary findings should be considered hypothesis-generating rather than confirmatory.

3.4. Relationships Among PLAN, DO, CHECK, and ACT Scores

Spearman correlation analysis was used to examine relationships among the four PDCA phases. All correlations were positive and statistically significant at $p < 0.001$. The strongest correlation was found between CHECK and ACT, with $\rho = 0.956$. This means that hotels that monitor eco-label processes are also more likely to review and improve them. The very high CHECK–ACT correlation indicates that monitoring and improvement activities were closely connected in the analyzed hotels. This result is theoretically plausible because corrective action and continual improvement usually depend on monitoring, measurement, and internal review. However, the high correlation also suggests possible overlap between the CHECK and ACT dimensions. Since the study did not use regression modelling, structural equation modelling, or predictive models based on the four PDCA scores, this correlation did not create multicollinearity bias in coefficient estimation. Nevertheless, it should be considered when interpreting the distinctiveness of the CHECK and ACT phases. PLAN was also strongly related to CHECK, with $\rho = 0.922$. PLAN was strongly related to DO, with $\rho = 0.888$, and to ACT, with $\rho = 0.867$. The correlation between DO and CHECK was $\rho = 0.731$. The correlation between DO and ACT was

$\rho = 0.672$. These values show that operational implementation alone does not guarantee monitoring and improvement (Table 5).

Table 5. Spearman correlations among PDCA phase scores.

Relationship	Spearman's ρ	Significance
PLAN-DO	0.888	$p < 0.001$
PLAN-CHECK	0.922	$p < 0.001$
PLAN-ACT	0.867	$p < 0.001$
DO-CHECK	0.731	$p < 0.001$
DO-ACT	0.672	$p < 0.001$
CHECK-ACT	0.956	$p < 0.001$

These results support RH5 because PLAN-phase maturity was positively related to DO-phase, CHECK-phase, and ACT-phase maturity. They confirm that the PDCA phases are connected. However, the lower correlations between DO and the later phases show that practical activities are not always followed by measurement, review, and improvement.

The reliability analysis showed excellent internal consistency of the eco-label process maturity questionnaire. The full 116-item questionnaire had a Cronbach's alpha value of 0.996. The reliability values were also very high for all PDCA phases. The PLAN phase, with 38 items, had an alpha value of 0.991. The DO phase, with 50 items, had an alpha value of 0.994. The CHECK phase, with 14 items, had an alpha value of 0.984. The ACT phase, also with 14 items, had an alpha value of 0.983. These results show that the questionnaire had a high level of internal consistency. However, very high Cronbach's alpha values should be interpreted carefully. They may indicate strong internal consistency, but they may also suggest overlap or redundancy among some items. This is possible because several items intentionally measured related aspects of environmental management, documentation, monitoring, and improvement. Therefore, the reliability results support internal consistency, but they do not by themselves confirm the full dimensional validity of the instrument.

4. Discussion

The results show that eco-label process maturity in WB6 hotels is still uneven and incomplete. The mean maturity index was below the middle of the scale, and most hotels were classified at Level 1 or Level 2. This confirms that many hotels apply only fragmented environmental practices. They do not yet have a complete process system for planning, implementation, monitoring, review, and continual improvement. This finding is consistent with previous hotel-sustainability studies, which show that environmental practices often differ by the level of managerial commitment, organizational capacity, and formalized environmental management [55,56]. Certification status was the strongest differentiating factor. Certified hotels had much higher maturity scores than non-certified hotels. This supports RH1 and confirms that formal management systems provide an important basis for eco-label readiness. Similar studies on ISO 14001 and environmental certification in hotels also found that certified hotels tend to be more structured and, in many cases, larger and better organized than non-certified hotels [57,58]. This result is also consistent with eco-label schemes such as the EU Ecolabel and Green Key, where certification requires evidence, documented procedures, environmental criteria, and periodic verification [59,60]. However, certification status in this study was interpreted as general certification culture and prior experience with formal management-system requirements. It should not be interpreted as the isolated effect of environmental certification alone.

Hotel size and hotel category were also strongly associated with eco-label process maturity. This supports RH2 and RH3. Larger and higher-category hotels usually have more human, financial, and managerial resources. They are also more exposed to international guests, tour operators, and market pressure. This may be one reason why they are more able to develop formal sustainability procedures, although the present bivariate analysis cannot isolate the independent effect of each hotel characteristic. Similar empirical research in the hotel sector showed that organizational characteristics and top-management support are important determinants of sustainable-practice adoption [56,61]. The differences among WB6 economies were statistically significant, which gives limited support to RH4. However, the small effect size shows that country-level factors explained only a small part of maturity differences. Hotel-level factors, especially certification status, size, and category, appear to be more important than national context. This result is relevant for regional policy. Eco-label programs in the WB6 region should not be designed only at national level. They should also target specific hotel groups, especially micro and small hotels. This point is also important because the present sample only included 74 three-star hotels, representing 11.84% of the sample, while four-star and five-star hotels represented 87.84% combined. Since three-star hotels had a much lower mean maturity score than four-star and five-star hotels, a sample with a larger share of lower-category hotels would probably show an even lower regional maturity level. This means that the reported mean value of 39.76% may overstate the eco-label readiness of the wider WB6 accommodation sector.

The PDCA results provide the main managerial insights from the study. PLAN, DO, CHECK, and ACT were positively correlated, which supports RH5. However, CHECK and ACT had the lowest mean scores. This shows that hotels more often implement visible environmental actions than systematic monitoring and improvement. A hotel may reduce energy use, save water, or communicate green practices to guests, but this is not enough for mature eco-label implementation. Eco-label credibility requires records, indicators, internal review, corrective actions, and evidence of improvement. This finding also has implications for consumer trust. The Introduction showed that many travelers want more sustainable accommodation options and that standardized sustainability labels are important for market credibility. However, weak CHECK and ACT scores suggest that many hotels may lack the monitoring, review, and corrective-action processes needed to verify sustainability claims. Without measurable evidence and continual improvement, sustainability communication can remain aspirational rather than verifiable. This may reduce consumer confidence in eco-labels and weaken the competitive advantage that certification is expected to provide. This is also relevant for greenwashing governance. If hotels communicate sustainability claims without monitoring evidence, internal review, and corrective action, certification and eco-label communication may lose credibility. The proposed maturity index therefore has value as a pre-certification diagnostic tool because it identifies whether hotels have the internal processes needed to produce credible evidence before making external sustainability claims.

The supplementary facility analysis also showed that hotels with pools, spa/wellness facilities, fitness facilities, and congress halls had higher maturity scores. The association may reflect operational complexity. Hotels with more facilities usually have higher energy and water consumption, more waste streams, and more complex maintenance processes. They may therefore need more formalized environmental control. This study contributes to sustainable hospitality research by treating eco-label implementation as a process-maturity problem. It does not only ask whether hotels have environmental practices or certification. It measures whether hotels have the internal management system needed to support credible eco-label implementation. The proposed index can help hotels, certification

bodies, and policymakers identify weak points in the PDCA cycle and design targeted improvement measures.

4.1. Managerial and Policy Implications

For hotel managers, the proposed PDCA-based index can be used as a self-assessment tool. It can help managers identify whether the main weakness is in planning, implementation, monitoring, or improvement. For example, many hotels in this study had higher DO scores but lower CHECK and ACT scores. This means that managers should not only add new environmental practices; they should first establish measurable indicators, internal records, monitoring routines, and corrective-action procedures.

For certification bodies, the results show the need for stronger guidance on monitoring and continual improvement. Many hotels may be willing to improve sustainability performance, but they may lack practical knowledge on how to document evidence, conduct internal reviews, and close the PDCA cycle. Eco-label schemes could therefore provide simplified templates, audit checklists, and step-by-step guidance for CHECK and ACT activities.

For regional policymakers, the findings suggest that support should be targeted at specific hotel segments rather than only at the national level. The small effect size for WB6 economy differences shows that country context is less important than hotel-level characteristics. Micro, small, and lower-category hotels need simplified certification pathways, training, advisory support, and access to green finance. These actions would be consistent with the Green Agenda for the Western Balkans and could support more inclusive sustainability transformation in the regional hotel sector.

The EU Green Agenda for the Western Balkans and related regional support mechanisms could be used to translate these findings into practical instruments for the hotel sector. Policy measures could include co-financing schemes for micro and small hotels, vouchers for eco-label advisory services, subsidized energy and water audits, regional training programs for hotel managers, and digital templates for monitoring resource consumption. A regional eco-label readiness program could also be developed to harmonize basic sustainability requirements across WB6 economies while allowing for gradual progression toward recognized schemes such as the EU Ecolabel, Green Key, or GSTC-recognized standards. Such measures would help reduce the gap between policy ambitions and the operational capacity of hotels, especially in lower-maturity hotel segments.

The practical use of the model can also be organized according to maturity level. Level 1 hotels should focus on basic environmental awareness, assignment of responsibilities, identification of key resource-consuming processes, and simple records of energy and water usage, and waste production. Level 2 hotels should formalize environmental procedures, define measurable objectives, and prepare a basic eco-label implementation plan. Level 3 hotels should strengthen monitoring routines, internal checks, and documentation of evidence. Level 4 hotels should focus on internal audits, corrective actions, supplier engagement, and preparation for third-party certification or recertification. Level 5 hotels should move toward advanced performance benchmarking, digital monitoring, transparent reporting, and continuous innovation in sustainable hospitality operations.

Recommendations should also differ by hotel size. Micro and small hotels need simple tools, short checklists, training, advisory support, and low-cost improvements because they often have limited financial and managerial capacities. Medium-sized hotels should develop more formal procedures, employee training systems, and regular performance monitoring. Large hotels should integrate eco-label maturity into strategic management, digital resource monitoring, supplier standards, internal audits, and public sustainability reporting. The WB6 economy results should also be used carefully. Serbia had the highest mean maturity score, while Kosovo, Bosnia and Herzegovina, Albania, and North

Macedonia showed lower overall scores. However, the small WB6 effect size indicates that national context alone does not explain maturity differences. Therefore, regional actions should combine country-level support with targeted hotel-segment interventions. Lower-scoring economies may benefit from basic awareness programs, technical assistance, and simplified eco-label roadmaps, while more mature markets may benefit from advanced certification support, benchmarking, and digital monitoring tools.

4.2. Limitations and Future Research

This study has several limitations. First, the equal-weighting approach is a methodological limitation. All questionnaire items contributed equally to the Eco-Label Process Maturity Index, although some eco-label practices may be more important than others. In addition, the overall index was item-weighted rather than phase-balanced. PLAN and DO included more items than CHECK and ACT, which means that the total index may be more influenced by planning and operational implementation than by monitoring, review, corrective action, and continual improvement. Future research should compare the present item-weighted index with phase-balanced, subcategory-balanced, and expert-weighted indices. Sensitivity analyses would show whether the main conclusions remain stable under alternative weighting schemes.

Second, the questionnaire was developed through conceptual mapping to PDCA logic, environmental management principles, and hotel eco-label practices, but it was not validated through an independent external expert panel. Factor analysis, item-total analysis, and sensitivity checks were also not conducted in the present study. Future research should include expert calibration, pilot testing, exploratory factor analysis, confirmatory factor analysis, item-total analysis, and item-reduction procedures to further strengthen the content validity, construct validity, and dimensional structure of the instrument.

Third, the very high correlation between CHECK and ACT indicates that these two phases may overlap in practice. Although this did not create multicollinearity bias in the present analysis because no regression or structural model was estimated, it should be considered when interpreting the distinctiveness of the CHECK and ACT dimensions. Future research should test whether CHECK and ACT should remain separate phases in the questionnaire or whether some items should be refined, removed, or redistributed.

Fourth, the sampling procedure limits the generalizability of the findings. The study relied on structured datasets, publicly available hotel information, and hotel-level responses rather than a complete probabilistic sampling frame. Therefore, conventional response-rate, refusal-rate, and non-response-bias calculations were not possible. The overrepresentation of four-star and five-star hotels, the dominance of small hotels, and the very small number of large and 'other' category hotels also limit the interpretation of subgroup comparisons. Future studies should use official accommodation registers where available, calculate response and refusal rates, and test non-response bias.

Fifth, self-report bias and social desirability bias cannot be fully excluded. The empirical data included hotel-level responses provided by managers or responsible hotel representatives. Respondents may have overestimated the implementation of some environmental or management practices, especially when sustainability practices were perceived as desirable. Future studies should combine questionnaire responses with document checks, external audits, site visits, or objective performance indicators.

Sixth, certification status was treated as a broad binary variable. The certified group included different types of certification, such as environmental, quality, food-safety, and other management standards. This aggregation may partly overlap with the maturity questionnaire because certified hotels often already have documentation, monitoring, and management procedures. Future research should separate eco-label certification,

environmental management certification, quality management certification, food-safety certification, and other standards.

Seventh, the statistical analysis was based mainly on nonparametric bivariate tests and correlation analysis. These methods were appropriate for the distribution and ordinal-derived nature of the maturity scores, but they do not isolate the independent effects of certification status, hotel size, hotel category, facilities, and country context. Future research should apply multivariate models, such as generalized linear models, ordinal regression, quantile regression, or mixed-effects models with country-level controls, to test whether these variables remain significant predictors after controlling for one another.

Finally, the proposed index measures eco-label process maturity and readiness, not actual environmental performance outcomes. The study did not directly measure reductions in energy use, water use, waste generation, greenhouse gas emissions, guest trust, certification success, or audit results. Therefore, the index should be interpreted as a diagnostic measure of internal process maturity. Future research should combine the maturity index with objective environmental performance indicators, such as energy use, water use, waste generation, and food waste per guest-night.

Future research should develop the model in several directions. Comparative studies should apply the model in other European and non-European tourism regions. Longitudinal studies should examine how hotels move between maturity levels over time. Future work should test weighted scoring models and compare them with the equal-weighted index used in this study. Factor analysis or structural equation modelling could be used to test whether the 14 subcategories form empirically distinct dimensions. Future studies should disaggregate certification types and examine whether environmental certifications have stronger effects than quality or food-safety standards. Qualitative case studies could explain why some hotels close the PDCA cycle while others remain mainly at the DO stage. Policy evaluation studies could also test whether subsidies, training programs, and advisory support improve eco-label readiness among micro and small hotels. Future research could also connect eco-label process maturity assessment with digital monitoring and forecasting models for hotel resource management. Previous research in resource-management forecasting has shown that neural-network models can support complex planning tasks, and similar approaches could be explored for forecasting hotel energy and water usage, waste production, and resource-efficiency indicators [62].

5. Conclusions

This study developed and applied an Eco-Label Process Maturity Index for hotels in the WB6 region. The results show that eco-label readiness should be understood as a process-management issue, not only as the presence of environmental practices or certification. The main weakness was the incomplete closure of the PDCA cycle. Many hotels had some operational environmental practices, but weaker monitoring, review, corrective action, and continual improvement. This limits the credibility and long-term value of eco-label implementation.

The proposed index measures eco-label process maturity and readiness, not actual environmental performance outcomes. The study did not directly measure reductions in energy use, water use, waste generation, greenhouse gas emissions, guest trust, certification success, or audit results. Therefore, the index should be interpreted as a diagnostic measure of internal process maturity. It indicates whether hotels have the management conditions needed to support credible eco-label implementation, but it does not prove actual sustainability performance without external performance data or certification audit evidence.

The findings show that certification status, hotel size, hotel category, and WB6 economy are associated with different maturity levels. These results can help hotel managers,

certification bodies, and policymakers identify where support is most needed. Micro and small hotels should first introduce simple environmental records, basic employee training, energy- and water-saving checklists, waste-separation routines, and a basic eco-label implementation plan. Medium-sized hotels should develop formal procedures, measurable sustainability indicators, internal monitoring routines, and documented corrective actions. Large and higher-category hotels should move toward digital resource monitoring, internal audits, supplier sustainability requirements, transparent reporting, and preparation for recognized eco-label certification or recertification.

The practical implication is that eco-label strategies in the Western Balkans should be targeted rather than generic. Lower-maturity hotels need basic awareness, operational control, and simplified certification pathways. More mature hotels should focus on closing the PDCA cycle through monitoring, review, corrective action, and continual improvement. In this way, the proposed index can support more credible, measurable, and segment-sensitive eco-label implementation in the regional hotel sector.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su18157760/s1>, Table S1: Eco-label process maturity questionnaire with 116 items grouped into 14 PDCA subcategories; Table S2: Scoring procedure and maturity-level classification used for calculating the Eco-Label Process Maturity Index; Table S3: Additional descriptive statistics and statistical tests for group comparisons and PDCA relationships.

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Institutional Review Board Statement: Ethical review and approval were waived by the Faculty of Mechanical Engineering, University of Niš, Serbia (Approval/Exemption Code: 612-74-79/2026; Date: 02/07/2026), because the study was a low-risk, non-interventional organizational survey involving adult professional respondents and non-sensitive organizational data. The study did not involve medical or clinical research, patients, vulnerable participants, biological material, human tissues, experimental treatment, or intervention with human participants.

Informed Consent Statement: Informed consent was obtained from all the respondents involved in the study.

Data Availability Statement: The data presented in this study are available on request.

Conflicts of Interest: The authors declare no conflicts of interest.

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