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A COMPARATIVE ANALYSIS OF MONITORING, WATER TREATMENT AND WASTE MANAGEMENT SYSTEMS IN THE CONCEPT OF SUSTAINABLE DEVELOPMENT OF SOUTH AND SOUTHEAST ASIA RESORTS

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The article examines ecotechnologies implemented by modern resorts in the South and Southeast Asia region. In particular, water desalination systems using solar energy, rainwater use, and water desalination are widespread. Waste management schemes are dominated by the rejection of plastic and its replacement with alternative materials. When evaluating guest reviews of eco-oriented resorts, interaction with natural ecosystems, both in passive and active recreation – hiking, snorkeling, kayaking, cruises, etc., is of primary importance. When evaluating the room stock, the ergonomics of the room, the absence of noise, and the importance of natural materials in decoration are most often mentioned. In the exteriors, resort guests pay attention to the presence of greenery and natural materials used in the construction of bungalow walls and ceilings. Consumers rarely mention specific eco-technologies in most resorts, but they perceive their presence positively, especially for a resort that clearly lists the implemented eco-technologies and emphasizes the ecological concept of the resort even in the name. The modern perspective of resorts in South and Southeast Asia is to ensure the protection of territories not their own, but those located close to the resort. In particular, the following are relevant and effective: an agreement with local community to lease the Island of Batbitim; the Misool Manta Project of research on both Okeanic mantas and Reef mantas; the Misool Community Recycling Project from Misool Eco Resort. Monitoring systems are rarely used, but are important for assessing the quality of the environment, in particular atmospheric air, sea and drinking water. Therefore, the development and implementation of portable monitoring systems is an urgent task for resorts that support the ecological concept.

Key words: *monitoring, water treatment, water purification, waste management, ecological concept, ecotecture of urbanized systems.*

Левицька Олена. Порівняльний аналіз систем моніторингу, водопідготовки та управління відходами в концепції сталого розвитку резортів Південної та Південно-східної Азії

У статті розглянуті екотехнології, що впроваджуються сучасними резортами регіону південної та південно-східної Азії. Зокрема, розповсюдженими є системи опріснення води за рахунок сонячної енергії, використання дощової води, знесолення води. У схемах поводження із відходами переважає відмова від пластику та заміна його альтернативними матеріалами. При оцінці відгуків гостей екоорієнтованих резортів, важливими в першу чергу стає взаємодія із природними екоситеми як у пасивному відпочинку, так і у активному – піші прогулянки, снорклінг, каякінг, круїзи тощо. При оцінці номерного фонду найбільше згадуються ергономіка номера, відсутність шуму, підкреслюється важливість натуральних маетріалів у оздобленні. У екстер'єрах гості резортів звертають увагу на наявність зелених насаджень та натуральні матеріалі, що використовуються при побудові стін та стель бунгало. Споживачі достатньо рідко згадують конкретні екотехнології у більшості резортів, однак позитивно сприймають їх наявність, особливо для резорту який чітко позиціонує наявність впроваджених екотехнологій та підкреслює екологічну концепцію резорту навіть у назві. Сучасною перспективою резортів південної та південно-східної Азії є забезпечення захисту територій не власних, а тих, що розташовані близько до резорту. Зокрема, актуальними та ефективними є угода з місцевою громадою про оренду острова Батбітім; проєкт Misool Manta, що передбачає дослідження як океанічних, так і рифових мант; проєкт Misool Community Recycling Project від Misool Eco Resort. Системи моніторингу застосовуються рідко, однак мають важливе значення для оцінки якості навколишнього середовища, зокрема атмосферного повітря, морської та питної води. Тому розвиток та впровадження портативних систем моніторингу є актуальною задачею для резортів, що підтримують екологічну концепцію.

Ключові слова: *моніторинг, водопідготовка, очищення води, поводження із відходами, екологічна концепція, екотектура урбанізованих систем.*

Introduction. The number of ecotourists is growing [1], and accordingly, the hotel industry is beginning to implement environmental practices both to reduce the burden on the environment and in response to the growing environmental concerns of consumers of tourist services [2]. Biodiversity research is becoming relevant to ensure a caring attitude and species depletion in tourist areas. Thus, the authors [3] provide materials on the study of the species diversity of butterflies in ecotourism areas of India.

In addition, the introduction of eco-technologies such as the use of renewable energy, water conservation and waste reduction have a positive impact on profitability

due to the reduction of operating costs and the attraction of environmentally conscious tourists who are willing to pay more [4]. That is why the development of eco-tourism and eco-infrastructure is a promising direction, and one of the important decisions on this path is the creation of environmental criteria with an assessment of service, safety and environmental friendliness of the room stock, ensuring communication with natural ecosystems (rejection of concrete and asphalt covering, greening of the territory, selection of the location of the future resort in the conditions of a nature reserve, nature reserve, forest ecosystems, etc.). Such criteria are considered in articles [5, 6].

The resorts of South and Southeast Asia have a powerful natural potential, historically formed craft and construction technologies using environmentally friendly materials. In addition, the residents of these regions are currently experiencing the problem of unutilized household waste, in particular plastic, and the problem of ocean pollution. Therefore, the concept of eco-oriented resorts can be positively perceived not only by tourists from other countries, but also by the local population, who has the financial opportunity to relax at such resorts.

Matherials and methods. The analysis is based on the generalization of knowledge about the eco-technologies implemented at leading eco-oriented resort complexes in South and Southeast Asia as well as on the establishment of cause-and-effect relationships between the criteria for hospitality and environmental friendliness of the resort and their mention in vacationers' reviews on the Google platform [7]. The evaluation criteria are shown in Table 1.

Consumer reviews were analyzed using the integrated evaluation method based on consumer reviews, which considered the proportion of positive reviews of the resort according to the criteria described in Table 1. Resorts that implement an eco-oriented concept of operation are only forming their authentic tourist destination, accordingly, when choosing a quantitative indicator for sampling consumer reviews, they were based primarily on their available number, and among the services considered, it was the Google platform that provided the largest number of them.

Results and discussion. When choosing a place to rest, the consumer is always guided by the criteria of comfort and safety. Moreover, in the conditions of the growth of recreation facilities, the consumer can compare the service, creatives offered by the resort, materials used to equip the room stock and in the execution of exterior structures. An important factor is the environmental friendliness of the resort. This concept correlates with safety, since natural materials, the absence of synthetic coatings and plastic in the interiors are the key to a safe composition of atmospheric air, natural detergents reduce the risks of damage and dryness of the skin, dermatitis, a high level of greenery in the territory not only ensures close interaction with the natural environment, but also stimulates the purification of atmospheric air, natural products from their own gardens ensure the rejection of preservatives, dyes, flavor enhancers.

Traditionally, resorts implement eco-technologies to increase the level of environmental safety and protect vacationers from harmful environmental factors, while today creating a conceptual model of a resort that is focused on naturalness, remoteness from sources of anthropogenic impact, acceptance and translation of the goals and objectives of sustainable development. Thus, Kudadoo Maldives Private Island provides guests with organic food. The region of South and Southeast Asia, with its natural potential, can easily meet the needs of vacationers in landscaping. For Siempang Forest Lodge, technical solutions to protect water bodies and land are not prevalent. The resort is located in a natural ecosystem and allows guests to feel part of it, which is also environmentally friendly and meets the needs of many customers [8]. Moreover, a trend in recent years has been to organize their own gardens to grow organic fruits and vegetables, which are served in the resort's restaurants (Table 2).

As part of ensuring the functioning of a model that implements sustainable development objectives within the resort (and sometimes beyond, when eco-oriented research and programs are implemented in areas subject to destructive natural or anthropogenic impact), it is necessary to implement a safety risk management system, where one of the key aspects is the introduction of environmental quality assessment systems as a definitive means of identifying, preventing, or minimizing harmful effects on the health and well-being of resort guests.

Monitoring systems (Table 3) are quite indirectly represented in the resorts of the region, while today

Table 1

Resort evaluation criteria

Research criterion	Criterion description	Subject of analytics
Ecotechnologies	monitoring systems, water treatment, waste management	assessment of control frequency, accessibility and understandability of monitoring results, feasibility and ease of use of water treatment and plastic management systems
Service	efficiency of service staff	politeness, mobility in responding to requests, accompaniment and organization of leisure activities, friendliness, understanding of the client's wishes
Rooms	safety and environmental characteristics of the space	noise level, smoke, smell, operation of ventilation systems, landscaping, lighting, naturalness of materials used in the interior
Exterior	ecotextural characteristics of space	landscaping, covering of sites and roads, water bodies on the territory, naturalness of building materials, aesthetics of design
Nature	natural features of the territory	the presence of reserves, natural parks, recreational areas within the resort's location
Leisure	ways to organize the client's free time	availability of opportunities for active recreation (riding, running, swimming), observing wildlife

Table 2

Territorial features of eco-oriented resorts in South and Southeast Asia

Resort name	Siempang Forest Lodge	Radisson Blu Resort Phu Quoc	Misool Eco Resort	Kudadoo Maldives Private Island
Arrangement	Siempang, Cambodia	Phu Quoc, Vietnam	Raja Ampat, Indonesia	Lhaviyani Atoll, Maldives
Materials and construction	Natural fabrics and decor materials	Panoramic windows (natural lighting)	Plant materials in ceiling and furniture decoration	Sustainable building material
Landscaping	Completely landscaped, except for the pool area	More than half of the territory is greened	Most of the territory is greened	
Gardening	–	–	Using local products and own gardens	Using organic products

Table 3

Monitoring systems and eco-technologies implemented by eco-oriented resorts in South and Southeast Asia

Resort name	Radisson Blu Resort Phu Quoc	Misool Eco Resort	Kudadoo Maldives Private Island
Monitoring systems	–	Expanding of 1220 sq km of Marine Reserve [11]	–
Water Treatment Systems	–	Own water desalination stations, use of rainwater	Solar water desalination systems
Waste management systems	Minimal waste through thoughtful reducing [9, 10]	Organic waste is used as compost, which is used to enrich gardens.	Actively sorting and where appropriate the recycling of waste material, amenities and food [12] Glass-bottled drinking water [12] (reduce from plastic)

automated air and water control systems have been developed and tested. The content of nitrogen, sulfur, and carbon compounds is an important indicator in determining the air quality index and is one of the important criteria for the environmental friendliness of an infrastructure facility. Organoleptic indicators and the content of heavy metals are important indicators in assessing surface waters, which can also affect the level of demand for the resort and the state of its environmental quality.

Green resorts of South and Southeast Asia are often characterized by large-scale territory, often located on islands or peninsulas, which are limited by rocks, forests, mountains. And in these conditions there is a need for atypical technological solutions or the construction of local treatment facilities to ensure water supply. At the same time, there is a need for absolutely ecological solutions related to water conservation and purification of used domestic water. It is in such conditions that water management systems, including solar-powered desalination systems, are being implemented.

Territorial features also stimulate ways of dealing with one of the most discussed wastes today – plastic. This waste, unlike traditional waste from household and administrative buildings, bars, restaurants, does not decompose relatively quickly and requires pre-treatment (at least grinding) before disposal, has low potential as a raw material for biofuel production and does not have nutrients for use as fertilizer after composting. That is why waste management schemes are shifting away from plastic and replacing it with alternative materials.

In cases of water supply and waste management systems, resorts essentially not only create and support a model of sustainable development in a limited area, but also solve economic and logistical problems that require resorts in areas remote from concentrated infrastructure. This combination of environmental friendliness and pragmatic choice of the most optimal technologies generates the best experience of resorts of South and Southeast Asia, forming the concept of an eco-resort using the latest technologies and a smooth transition from the use of individual elements of interior and exterior decor to systemic design-based solutions.

Participation in international programs by eco-oriented resorts in South and Southeast Asia is becoming relevant (Table 4). Resorts often help local communities solve regional environmental problems or use craft products for interior and exterior decoration and organic products for restaurant supplies.

Using the example of the resorts considered in Table 3, one can be convinced of the new trajectory of development of resorts that position themselves as ecological. In this case, are not only talking about the complex spatial planning of the resort territory, but actually about the trend of resource-saving exploitation of tourist regions, which takes into account not only limited tools for minimizing negative

Table 4

Participation in international programs by eco-oriented resorts of South and Southeast Asia

Resort name	Radisson Blu Resort Phu Quoc	Misool Eco Resort
Participation in international programs	Support local communities	An agreement with local community to lease the Island of Batbitim; The Misool Manta Project of research on both Okeanic mantas and Reef mantas; The Misool Community Recycling Project

environmental impact, but also becomes a key factor in the formation of a new quality of the region (city, village) as a new eco-oriented tourist product.

Consumers of tourist services evaluate the resort taking into account the service, begin to pay attention to the implemented eco-technologies, evaluate the comfort and safety of the room stock and exteriors, in particular, pay attention to landscaping and pool areas, emphasize the importance of proximity to nature and active outdoor leisure. These consumer criteria are also included in the assessment of the quality of resorts in South and Southeast Asia and were determined by the frequency of positive mentions of them on the Google platform [7].

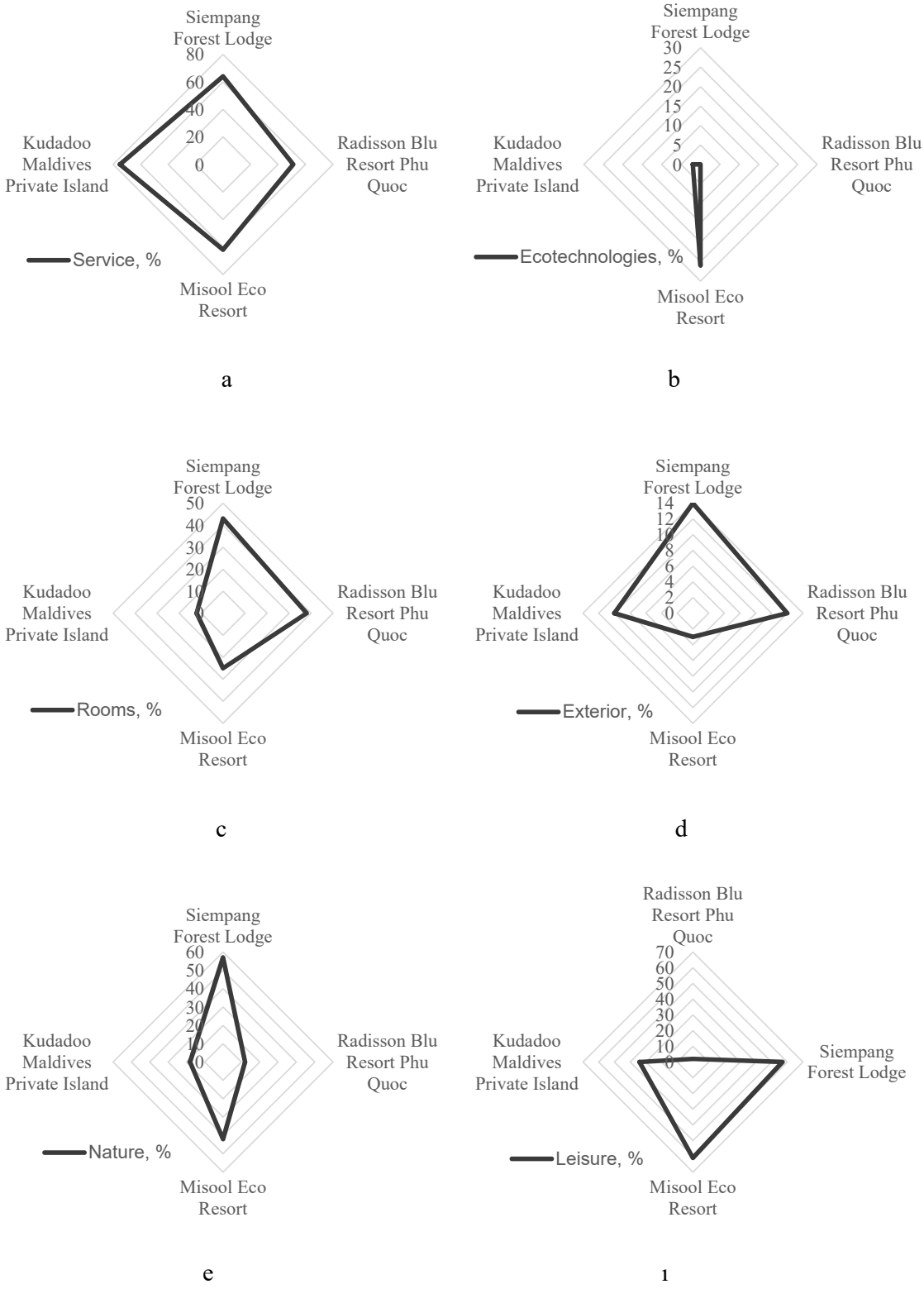

Fig. 1. Analytics of eco-oriented resorts in South and Southeast Asia by environmental and hospitality criteria, %

Interestingly, the overall rating for all considered resorts on the specified platform as of 02/21/2026 was 4.8 out of 5. The results of up to 50 guest reviews or all available for younger resorts were processed and entered into the diagrams in Fig. 1.

Service is important among guests of ecotecture objects (Fig. 1a). It is mentioned more often than other criteria by guests of all the resorts considered. Kudadoo Maldives Private Island has the highest indicators. Resort guests partially highlight eco-initiatives (Fig. 1b), indicating the importance of their implementation. Such initiatives are new and will be popularized in the future. The only one among the considered ones, Misool Eco Resort, demonstrates high indicators of guest satisfaction with the implemented eco-initiatives. One of the important aspects of conducting business activities with the positioning of sustainable development goals and ensuring environmental safety is the understanding that the client perceives the implementation of eco-technologies as an image conceptual element, accordingly not always understanding the completeness of eco-technologies and not feeling the need for them. Therefore, the traditional provision of service and hospitality tasks at the level or even higher than that of traditional resorts is one of the ways to familiarize the client with the new on the basis of high-quality provision of a familiar criterion. With the growth of conceptually ecological resorts and the provision of basic consumer needs at a high level, the acceptance and understanding of the resort's safety criteria will become possible and predictable.

An important feature of eco-oriented infrastructure facilities is the use of unobtrusive and dull interior and exterior styles. In particular, this is minimalism. Or exquisite historical interior styles such as baroque, but with the use of a restrained color scheme using colors close to natural. Consumers of tourist services usually highlight the comfort of the room, in particular the bed, the presence or absence of noise and the origin of finishing materials (Fig. 1c). The comfort and environmental friendliness of the rooms at the Siempang Forest Lodge and Radisson Blu Resort Phu Quoc resorts were most often mentioned positively. When assessing the exteriors, satisfaction with the green area, the scale of the pool and the materials from which the bungalow is made prevails (Fig. 1d). The exteriors were most often mentioned positively by guests of Siempang Forest Lodge. A significant number of positive reviews in the assessment of the number of rooms and exteriors today are still formed taking into account requests for comfort, the absence of harmful factors (such as noise) and aesthetic satisfaction of the client. However, this is far from a complete list of advantages that can be incorporated into the concept of an eco-oriented resort. Again, the formation of knowledge and needs in the consumer in eco-oriented service is gradual and will be formed only in conditions of ensuring high quality of familiar criteria, which should clearly provide resorts with a new concept.

Important aspects in the organization of eco-oriented resorts are proximity to natural ecosystems (Fig. 1e) and numerous activities, including outdoor activities (Fig. 1i). For example, the Misool Eco Resort, Indonesia, provides cruises, kayaking and stand-up paddleboarding. Kudadoo Maldives Private Island provides diving, snorkeling and yacht excursions. Resorts located practically within natural ecosystems – in forests, mountains, reserves and nature reserves – are becoming widespread. An example of such solutions is Siempang Forest Lodge. The resort offers hiking and bird watching in the ecosystems where they live, boat cruises. When evaluating resorts, Siempang Forest Lodge and Misool Eco Resort show a relatively high number of positive reviews related to nature and outdoor activities. Outdoor recreation and close proximity to natural parks and reserves are the resort's advantages and are positively evaluated by guests. Such a location, together with the provision of monitoring systems, water treatment and waste management, is an absolutely winning symbiosis, when a modern person feels a surge of strength, improved mental state and even physical well-being when interacting with natural ecosystems, at the same time not losing the traditional and familiar connection with the technological environment, but, unlike the infrastructure systems of a metropolis, for the first time feels the primacy of security goals and human orientation as one of the main elements of this new safe environment.

The methodology and research results correlate with the materials presented in articles [5; 6]. Consumers of tourist services in Europe [5], North America [6], Asia [3; 13; 15] also often highlight the natural features of the resort's location in the concept of sustainable development, and the not entirely ecological criterion – service – is also important and in demand. A more detailed study of the analysis of service quality assurance through resort managers is considered in [14], which is absolutely relevant for expanding the research base of conceptual resorts. Thus, implementing a relatively new ecological system of resort functioning, the standard quality criteria presented to all resorts (regardless of conceptual advantages) must be fully ensured. Article [1] appeals to water purification and waste management technologies, article [11] – monitoring technologies, which correlate with those described in this work. Although a numerical analysis of the mentions of these technological solutions is not provided, the relevance of their application is substantiated.

Conclusions. Analyzing the main technologies used by green resorts in South and Southeast Asia, it was found that for traditionally remote resort complexes that are separated from infrastructure or located on an island, the problems of water purification and management of waste that is difficult to decompose become important. In addition, the relevance and necessity of using environmental monitoring systems both within the territory of the resort and in the region where the resort is located are analyzed. The above technologies are assessed as key factors in the formation of the ecological concept of the resort as a new quality of the tourist product. The need to ensure high-quality service, safety of the room stock, and aesthetics of exteriors as a guarantee of the formation of an ecological concept that is atypical for the consumer has been established, and the relevance of combining natural, anthropogenically

unchanged ecosystems and the latest technological solutions within the resort has been shown, which form a new quality of tourist experience, where a person finds himself, on the one hand, in a familiar technological environment (however, designed primarily to ensure his safety), and on the other hand, experiences positive changes, interacting with natural ecosystems. In this context, monitoring, water treatment, and waste management systems act not only as a technical and operational element, but also as a component of a holistic conceptual offer of the resort, which directly affects the perception of service quality and the level of trust of consumers.

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