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"Empowering Sustainable Ecotourism through Blockchain: A Scalable Eco-Credit Model for Protected Areas. Case of Shouf Biosphere Reserve, Lebanon"

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Abstract:

Ecotourism presents a valuable pathway toward sustainable development, yet in Lebanon, it faces complex structural and contextual barriers. This study aims to explore the challenges hindering effective ecotourism in the Shouf Biosphere Reserve and to propose innovative solutions to foster sustainability. Using a qualitative research design, data were collected through 15 semi-structured interviews with diverse stakeholders, including governmental bodies, reserve management, municipalities, NGOs, and private sector representatives. Thematic analysis revealed political instability, economic fragility, donor dependency, cultural ambivalence, and trust-related challenges as central factors influencing ecotourism-related practices. Addressing these challenges, the study introduces a blockchain-based eco-credit system designed to incentivize verified sustainable practices by assigning eco-credits based on quantifiable environmental and social performance metrics. This decentralized platform enhances transparency, accountability, and stakeholder engagement, enabling a scalable and trustworthy model for ecotourism governance. A practical application at Cezar Farmville Guesthouse demonstrates how such a system can quantify sustainability efforts and provide tiered incentives. The findings highlight blockchain's potential as a transformative tool to bridge gaps between ecotourism aspirations and implementation in fragile socio-political contexts. Ultimately, this integrated approach offers a promising pathway to empower local communities, enhance environmental stewardship, and advance Lebanon's sustainable tourism goals.

Keywords: Ecotourism, Sustainable Development, Blockchain Technology, Eco-credit system, Shouf biosphere reserve, Lebanon.

Introduction:

Ecotourism has emerged globally as a promising vehicle for sustainable development, offering a model that balances environmental conservation with socio-economic benefits for local communities. In Lebanon, a country rich in biodiversity, cultural heritage, and community-based tourism potential, the ecotourism sector holds significant promise. However, its effective implementation remains constrained by systemic and contextual challenges. This article explores how ecotourism is perceived and practiced across the Lebanese landscape, drawing on insights from key stakeholders—including municipalities, NGOs, guesthouse owners, and ecotourism practitioners—particularly within the Shouf Biosphere Reserve. Compounding these issues, the COVID-19 pandemic has significantly hindered global efforts to achieve the Sustainable Development Goals (SDGs), with negative impacts across all dimensions—from rising poverty to weakened environmental commitments (UN DESA, 2020). Lebanon's own progress has been further obstructed by political instability, deepening economic crises, and poor governance, ranking 110 out of 166 on the SDG index (Sachs et al., 2024).

These structural deficiencies not only dilute the authenticity of ecotourism practices but also expose the sector to superficial branding and greenwashing. In response to these challenges, this paper introduces a blockchain-based eco-credit system designed to improve transparency, incentivize responsible practices, and promote long-term sustainability across the tourism value chain. By integrating decentralized technology with measurable sustainability indicators, the proposed model offers a practical, scalable solution to strengthen ecotourism governance, reward best practices, and foster trust among stakeholders. The article ultimately aims to bridge the gap between aspiration and implementation in Lebanon's ecotourism sector. Where it proposes a blockchain-based eco-credit system tailored for Lebanon's tourism and hospitality sector. By incentivizing verified sustainability efforts, the model offers a transparent, scalable solution to overcome systemic challenges and support both local and national sustainability goals.

Literature Review

Ecotourism and sustainable development are deeply interconnected, particularly in regions where tourism functions as a mechanism for both environmental conservation and socio-economic empowerment. The concept of sustainable development was formally defined by the Brundtland Commission in 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Since the 1992 Rio Earth Summit, sustainability has become a guiding principle within the tourism sector (UNWTO, 2019). The International Ecotourism Society (TIES) defines ecotourism as "responsible travel to natural areas that conserves the environment, sustains the well-being of local people, and involves interpretation and education" (TIES, 2015). Ecotourism is widely promoted as a tool for

sustainable development because it supports biodiversity conservation while enhancing rural livelihoods. For example, studies by Gurung and Seeland (2008) and Tyler and Dangerfield (2008) highlight its potential to generate employment, preserve cultural heritage, and offer educational opportunities.

However, the success of ecotourism depends on effectively integrating ecological sustainability with economic viability. Qualitative findings from the Shouf Biosphere Reserve reveal systemic challenges such as fragmented governance and poor coordination among ministries, municipalities, and NGOs (Hakim, 2025). Municipalities often face financial strain and limited administrative capacity, diverting attention from ecotourism to pressing social services. Additionally, the absence of clear standards leads to superficial implementations and misuse of the ecotourism label, risking "greenwashing" and undermining sector credibility (Jones & Clark, 2016). Economic instability and reliance on short-term donor projects further compromise long-term infrastructure and planning (Spenceley, 2018). These persistent issues—including fragmented governance, lack of transparency, and unreliable funding—highlight the urgent need for systemic reforms in ecotourism management and monitoring.

Blockchain technology presents a promising solution within this context by providing a decentralized, transparent, and tamper-proof platform. It can improve stakeholder coordination, ensure authenticity in ecotourism practices, and empower community-led governance models (Kouhizadeh & Sarkis, 2018; Saberi et al., 2019).

Introduction to Blockchain Technology

Blockchain technology, first introduced by Nakamoto (2008), has redefined digital trust by enabling decentralized, transparent, and secure data transactions. Unlike centralized databases, blockchain uses a peer-to-peer structure and consensus protocols to validate transactions, ensuring data integrity through cryptographic hashing (Mougayar, 2016). It eliminates the need for third-party intermediaries and provides real-time traceability, which makes it valuable for sustainability applications (Hutt, 2016). Beyond cryptocurrency, blockchain has been widely applied in sectors such as finance, healthcare, and supply chains, offering resilience and efficiency. Its decentralized nature minimizes single points of failure and facilitates trusted collaboration among institutions (Kruglova & Dolbezhkin, 2018; Casey et al., 2018).

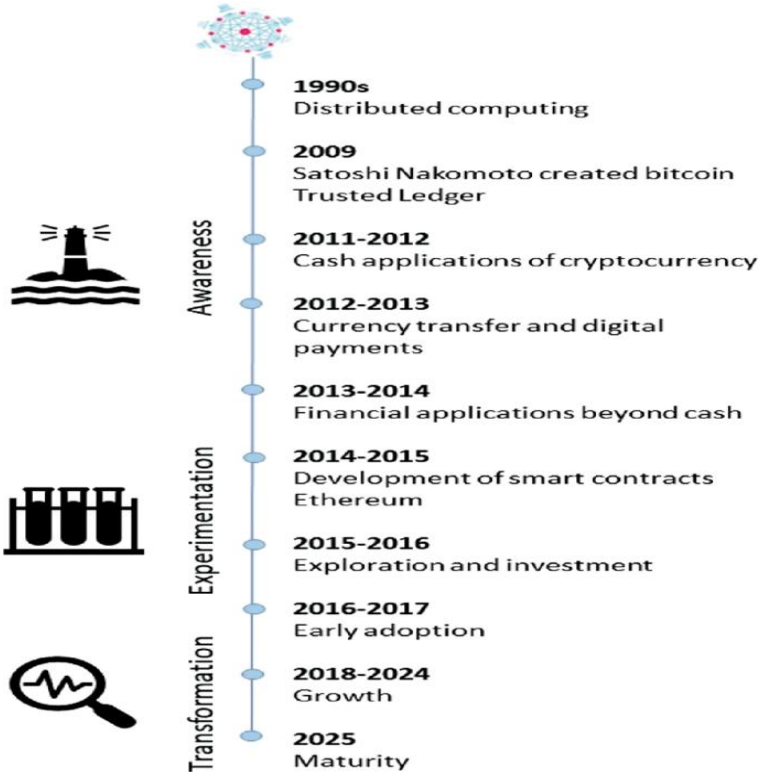

Figure1: The evolution of Blockchain over time (Accenture, 2015; PwC, 2017; Capgemini, 2018)

Blockchain for Advancing Sustainable Development

Despite concerns about energy usage, blockchain has proven to be a powerful tool for enhancing transparency in sustainable development initiatives. It enables verifiable data collection on environmental impacts and improves institutional accountability. For example, local utilities can use blockchain to track water consumption or waste production, enabling informed decision-making at both policy and community levels (Cheng et al., 2023). Moreover, blockchain fosters stakeholder engagement by allowing equal access to data, empowering local communities to participate in sustainability governance. The technology can also streamline sustainability certifications, optimize resource use, and improve resilience in infrastructure and environmental monitoring systems.

Blockchain enabled Solutions across SDGs

Real-world applications of blockchain span various SDGs. In water management (SDG 6), platforms like Waterig use IoT-linked blockchain systems to monitor distribution networks (Suen, 2020). In energy (SDG 7), projects like RENeW Nexus in Australia facilitate peer-to-peer trading of solar power (Power Ledger, 2020). In waste reduction (SDG 12), tools like Swachhcoin convert waste into energy and track recycling progress (Gopalakrishnan & Radhakrishnan, 2019). Blockchain also supports carbon markets (SDG 13) by verifying carbon credits, as in IBM's blockchain-enabled trading platform (IBM, 2018). These cases affirm blockchain's potential to support data integrity, incentivize eco-actions, and accelerate progress toward sustainability goals (Schroeder et al., 2018; WEF, 2014).

Methodology

This study adopts a mixed method between quantitative and quantitative research design grounded in interpretive inquiry, aimed at uncovering the underlying perceptions, institutional challenges, and governance dynamics that shape the implementation of ecotourism within the Shouf Biosphere Reserve (SBR) in Lebanon. By privileging depth over breadth, the study seeks to capture the complexity of stakeholder experiences and institutional realities. The quantitative and qualitative approach is complemented by a conceptual methodological framework proposing a blockchain-based eco-credit system designed to address governance and sustainability gaps identified throughout the empirical inquiry.

Data Collection through Semi-Structured Interviews

Data were collected through 15 semi-structured interviews conducted with stakeholders from various sectors involved in ecotourism within the SBR. Interviewees included reserve directors, ecotourism coordinators, field rangers, local municipality leaders, guesthouse owners, environmental NGO staff, communication officers, and operational teams working at the reserve's access points. Participants were selected based on their active engagement in ecotourism-related activities or decision-making processes, ensuring diverse and institutionally relevant perspectives.

Interviews were conducted in Arabic and English, depending on the interviewee's preference.

Analytical Process: Thematic Coding and Interpretation

An inductive thematic analysis was conducted using Braun and Clarke's (2006) six-phase framework: (1) familiarization with the data, (2) generating initial codes, (3) searching for themes, (4) reviewing themes, (5) defining and naming themes, and (6) producing the report. Transcribed interviews were read multiple times to ensure deep familiarization, followed by the coding of recurring phrases, institutional dynamics, and stakeholder reflections. A latent approach was also applied to uncover underlying meanings. NVivo 12 software facilitated code management and comparative analysis across stakeholder groups. Analytical rigor was ensured through researcher reflexivity, memoing, triangulation of views, and peer debriefing.

Conceptual Integration: Blockchain-Informed Governance Design

Although the empirical study employed qualitative methods, a complementary conceptual layer was developed in response to recurring issues related to transparency, resource accountability, and weak institutional coordination. Informed by international best practices in environmental governance and digital accountability, the study proposes a blockchain-based eco-credit system as a forward-thinking framework for enhancing institutional performance and visitor participation in ecotourism settings. The model envisions a digitally governed credit system in which sustainable behaviors—such as adherence to ecotourism codes, contributions to conservation, or collaboration with local actors—are rewarded through smart contracts on a blockchain platform. These credits can be redeemed for benefits within the tourism ecosystem or used to access additional services or certifications. Each transaction is logged transparently, creating an immutable ledger of sustainable practices that supports both trust and traceability. From a methodological standpoint, the inclusion of this conceptual component reflects a commitment to transformative tourism research that not only diagnoses systemic problems but also explores viable pathways for reform. The eco-credit model is elaborated in a theoretical context that intersects with sustainability transitions, smart governance, and post-crisis tourism resilience—offering future researchers and practitioners a concrete direction for applied innovation.

Key Steps in Developing the Eco-Credit Token (ECT) System

The implementation of the eco-credit system involves several essential stages that ensure both technical soundness and institutional credibility. These steps are necessary to create a secure, transparent, and functional blockchain-based reward system that supports and verifies sustainable practices.

1. Creating ECT Stake, Validation Software, and ECT Wallet

This step focuses on building the technical infrastructure of the eco-credit system. Participants stake ECT tokens to ensure transaction legitimacy and network security. Institutions use ECT wallets to securely store and manage tokens. A suitable blockchain platform (e.g., Ethereum, BSC) must be chosen or developed, with strong security measures such as encryption, multi-signature wallets, and two-factor authentication.

2. Institutions to Apply for the Program (Terms and Conditions)

Interested institutions must formally apply and agree to program terms. A simple application process—possibly through an online portal—should be developed. Institutions must commit to sustainable practices and cooperation with monitoring systems.

3. Approved Institutions to be Inspected On-Site

To maintain integrity, approved institutions will undergo on-site inspections based on a standardized checklist. If physical visits are not possible, virtual inspections using IoT or remote tools can be implemented.

4. Install Software, Monitoring, and Data Collection Systems

Institutions must implement systems to track and report sustainable practices. These must be compatible with existing infrastructure and ensure secure data handling, with attention to privacy concerns.

5. Creation of ECT Wallet

Each institution receives a secure and user-friendly wallet (mobile, desktop, or hardware) with encryption, recovery options, and authentication. Wallets must integrate seamlessly with the blockchain.

6. System Launch

Once systems are in place and institutions are ready, the eco-credit platform can officially go live. A communication and outreach plan is essential to promote awareness and participation.

7. Data Collection through the Blockchain

Sustainability-related data (e.g., emissions, energy use) will be recorded, stored, and verified on the blockchain. Clear data access protocols must be defined to protect sensitive information.

8. Verification of Sustainability Compliance

Institutions will be periodically assessed against program criteria. A verification protocol must be established, detailing frequency, requirements, and penalties for non-compliance.

9. 9. Distribution of ECT Tokens as Rewards

Institutions that meet sustainability standards will receive ECT tokens as rewards. A transparent, automated distribution system using smart contracts should be used to ensure fairness and security.

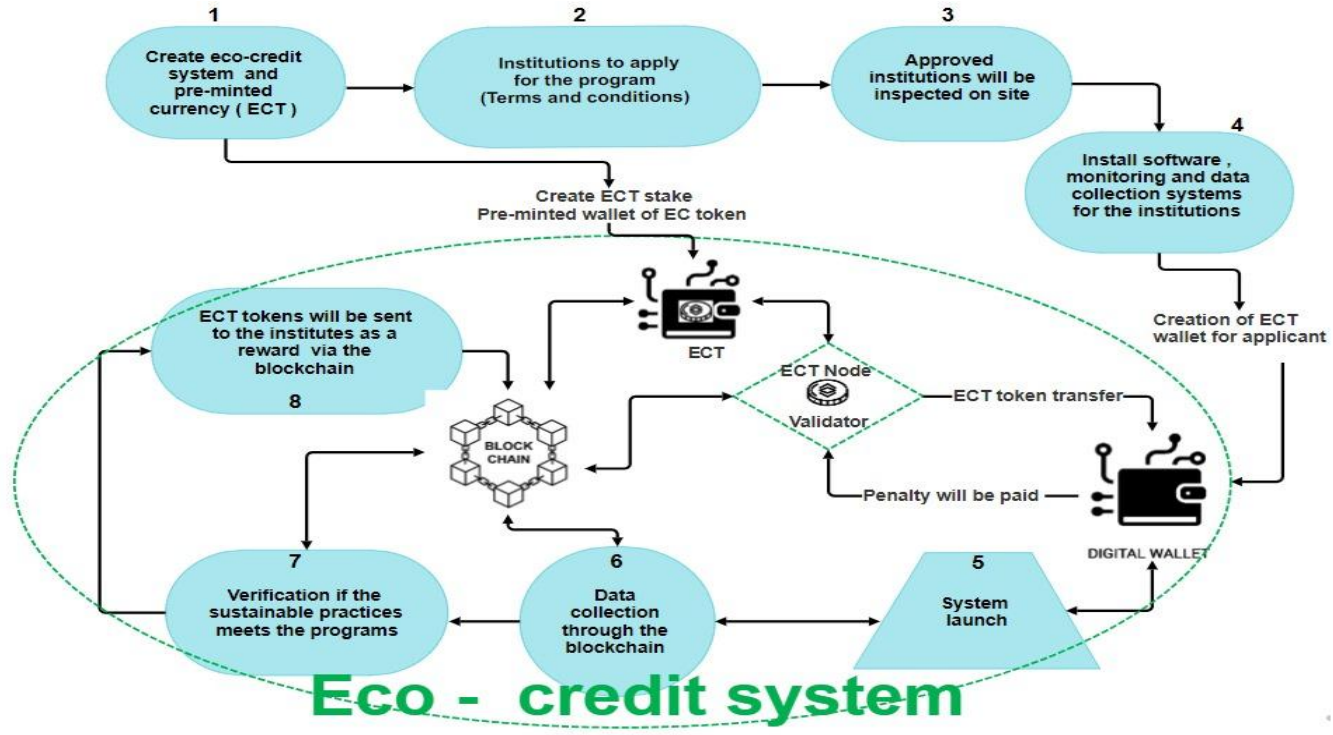

Figure 2: Steps involved in the design of the Eco-Credit System (adapted from Schweik, 2022)

General overview of the Research Area Shouf District in Lebanon

Map: The Shouf District, Lebanon. Source: Google Maps, 2024

The Shouf district, one of the largest in Lebanon, encompasses 125 villages and towns, stretching from Naameh in the north to Ramliyeh near Sidon in the south, and from the seashore to JabalBarouk, Niha, and Ain Zhalta in the east. The villages are spread out, leading to differences in human and social relations across regions such as Iqlim Al-Kharroub, Upper Shouf, and Middle Shouf. The district's proximity to the capital and its rich geography, from the coast to Barouk Mountain's peaks, highlights the importance of preserving this natural environment. In turn, this supports the growth of economic sectors like tourism, which creates job opportunities and helps the local community sustain their livelihoods (Alghoussaini, 2016). To promote ecological conservation and raise the awareness of local communities to the rewards of an eco-friendly environment, the Shouf Cedars Nature Reserve has paid special attention to ecotourism. It has introduced several activities including hiking, biking, snowshoeing, trekking, bird watching, and animal observation… and has trained local young men and women to act as tourist guides and show visitors around. Each year, 70,000 nature lovers and outdoors enthusiasts visit the Reserve through one of its five main entrances. Ultimately, due to the presence of these activities and the significant number of visitors to the area, the development of restaurants, hotels, guesthouses and campsites naturally followed. Accordingly, for this study the Shouf region was selected as a starting point to design and develop a tailored eco-credit system to accelerate sustainable practices.

Results

Stakeholder-Perceived Structural and Contextual Constraints

The qualitative phase of this study comprised semi-structured interviews with 15 stakeholders operating at national, regional, and local levels within and around the Shouf Biosphere Reserve. Participants represented a wide spectrum of institutional affiliations, including public authorities, reserve management, municipalities, private sector actors, NGOs, and independent experts. Rather than focusing on operational definitions of ecotourism, this phase sought to uncover the broader structural, political, and socio-economic conditions shaping stakeholders' experiences and expectations of tourism-related initiatives in the Shouf region. Across interviews, participants consistently situated ecotourism-related practices within Lebanon's wider context of political volatility, economic deterioration, and institutional fragility. These contextual pressures were not treated as background conditions, but as active forces influencing decision-making processes, stakeholder relationships, and long-term planning capacities.

Political Instability and Institutional Uncertainty

At the national level, interviewees described a persistent state of political instability that has undermined continuity in tourism- and environment-related initiatives. Frequent changes in leadership, policy paralysis, and delayed decision-making were reported to create an environment of uncertainty, where projects are often launched without assurance of long-term political backing. Stakeholders emphasized that shifting political priorities weaken institutional memory and disrupt coordination across sectors, leading to stalled initiatives and fragmented implementation efforts. This uncertainty was echoed at regional and local levels, where actors reported difficulties aligning their activities with national strategies that are perceived as inconsistent or short-lived. As a result, many stakeholders adopt reactive rather than strategic approaches, prioritizing short-term survival over long-term development objectives.

Economic Crisis as a Dominant Constraint

The ongoing economic crisis emerged as a central theme across nearly all interviews. Stakeholders consistently described severe financial constraints affecting institutions, municipalities, and local enterprises alike. Reduced public budgets, currency devaluation, and declining purchasing power were reported to limit investment in infrastructure, maintenance, and service quality. At the municipal level, respondents explained that limited financial resources have forced local authorities to redirect attention toward urgent social and humanitarian needs, leaving tourism-related initiatives underfunded and deprioritized. Private sector actors similarly noted rising operational costs and declining consumer spending, which restrict innovation and discourage long-term commitments. Importantly, the economic crisis was also described as reshaping stakeholder behavior, fostering risk aversion and discouraging experimentation with new models or technologies.

Donor Dependency and Project Fragmentation

Another dominant pattern across interviews was the heavy reliance on donor-funded projects. While external funding was acknowledged as essential for sustaining activities under current economic conditions, stakeholders expressed concern that donor dependency contributes to fragmented, short-term interventions. Several interviewees noted that donor priorities often shape project design and timelines, sometimes at the expense of locally defined needs or long-term integration. This dynamic was described as producing a cycle of pilot initiatives that lack continuity once funding ends, reinforcing uncertainty among local actors and weakening institutional learning. NGO representatives and practitioners highlighted that donor-driven accountability mechanisms tend to focus on reporting outputs rather than fostering durable systems, further limiting the sustainability of interventions beyond funding periods.

Cultural Ambivalence Toward Tourism-Led Development

Interviews also revealed a nuanced and sometimes contradictory relationship between local communities and tourism-related activities. While tourism is widely recognized as a potential economic opportunity, stakeholders described a form of cultural ambivalence toward its expansion. Some participants observed that tourism is perceived simultaneously as a source of income and as a disruptive force that alters social norms, land use patterns, and community dynamics. This ambivalence was particularly evident in rural areas, where traditional livelihoods coexist uneasily with externally driven tourism models. Such tensions were reported to influence community participation, with engagement often shaped by immediate economic incentives rather than long-term collective vision. Stakeholders noted that this dynamic complicates collaboration and limits the emergence of shared objectives among actors.

Trust Deficits and Relational Struggles

A recurring cross-cutting issue was the presence of trust-related challenges among stakeholders. Interviewees described varying degrees of skepticism between public institutions, private operators, NGOs, and local communities. This lack of trust was attributed to past experiences of unfulfilled promises, opaque decision-making, and inconsistent follow-through on initiatives. Several stakeholders emphasized that trust deficits discourage information sharing and collective action, reinforcing siloed operations. In some cases, local actors expressed hesitation to engage in new initiatives due to fears of exclusion, misrepresentation, or unequal benefit distribution.These relational struggles were further intensified by economic hardship and political instability, creating an environment where cooperation is perceived as risky and accountability mechanisms are weak.

Synthesis of Structural Constraints

Taken together, the findings indicate that stakeholder experiences of ecotourism-related initiatives in the Shouf Biosphere Reserve are deeply embedded within interconnected political, economic, cultural, and relational constraints. Political instability undermines institutional continuity, the economic crisis restricts resources and innovation, donor dependency fragments interventions, cultural ambivalence complicates local engagement, and trust deficits weaken collaboration. Rather than isolated challenges, these factors interact dynamically, shaping how stakeholders perceive opportunities, risks, and responsibilities. Understanding this complex landscape is essential for exploring alternative frameworks and tools capable of addressing coordination failures, transparency gaps, and long-term resilience in ecotourism-related systems.

From Structural Challenges to Technological Solutions: Introducing Blockchain for Sustainable Ecotourism

While the qualitative findings underscore a range of institutional, economic, and educational challenges that hinder the effective implementation of ecotourism in the Shouf Biosphere Reserve, these barriers also open the door for innovative solutions. In particular, the structural issues of fragmented governance, lack of transparency, weak accountability, and unreliable funding mechanisms point to the need for a systemic shift in how ecotourism is managed and monitored. Within this context, **blockchain technology emerges as a promising tool** to address many of these limitations. By offering a decentralized, transparent, and tamper-proof infrastructure, blockchain can enhance coordination among stakeholders, ensure

the integrity of ecotourism practices, facilitate secure and traceable financial transactions, and support community-driven governance models. The following section explores how blockchain-based systems—particularly those designed for environmental sustainability and ecotourism certification—can be strategically applied to overcome the challenges identified in the qualitative analysis and drive more inclusive, accountable, and resilient ecotourism development in Lebanon.

This proposed blockchain-based system is designed to be implemented across various tourism-related accommodations, including hotels, guesthouses, restaurants, campsites, and eco-lodges operating within and around the Shouf Biosphere Reserve. The platform would function as a decentralized certification and rewards mechanism, where each establishment is evaluated based on its adoption of recognized sustainable practices. These include waste reduction and recycling, energy efficiency (e.g., use of solar panels and LED lighting), water conservation techniques, sustainable sourcing of food and materials, participation in credible certification programs (such as Green Key or Ecotourism Lebanon), and meaningful engagement with the local community. The more an entity integrates and maintains these practices, the higher its credibility and potential benefits within the system—both reputational and financial—thereby creating a transparent and incentivized model for sustainable tourism development.

Eco-credit System and Scoring Technique:

A blockchain-based eco-credit system should consider several scoring factors to ensure fairness and adoption. Key criteria include implementation costs (IRENA, 2020), time and effort required (WorldGBC, 2018), and ease of adoption (USGBC, 2019). Environmental impact is central—practices that significantly reduce emissions or resource use deserve more credits (UNEP, 2021). ROI also matters, with low-return actions needing higher incentives (McKinsey, 2020). Scalability and social impact—such as community support (WRI, 2020)—should be rewarded, while going beyond regulatory compliance justifies bonus credits (IEA, 2021). Aligning with consumer trends can reduce the credits needed for adoption (Deloitte, 2020).

Proposed Eco-credit Formula and System:

To accurately reward sustainable practices, we propose the following formula for calculating eco-credits:

Total credit-credit score = Score Metric × Weight Factor

This formula considers both the measurable performance of a practice (its score) and its relative importance (its weight). Table10 provides the fixed scores for the different sustainable practices based on specific metrics.

Table: Fixed Eco-credit Scores for Sustainable Practices based on Specified Metrics

Categories	Metric	Eco-credit Scores
Energy Savings	KWh saved	100 eco-credits per 1000 Kwh
Waste reduction	Tons of waste reduced	50 eco-credit per ton
Water Usage	Liters saved	75 eco-credits per 10,000 liters
Biodiversity Impact	Area protected (hectares)	200 eco-credit per hectare
Certification and Standards	Certifications achieved	500 eco-credits for LEED gold
Sustainable Sourcing	Percentage of sustainably sourced goods	100 eco-credits per 10% increase
Sustainable packaging	Reduction in non-recyclable packaging	150 eco- credits per 10% reduction
Sustainable Building	Sustainable materials used	200 eco-credits per 10% increase

Social Responsibility	Community impact initiatives	100 eco-credit per initiative
Community Engagement	Events or programs launched	100 eco-credit per event
Eco-friendly operations	Reduction in carbon footprint	250 eco-credits per 5% reduction
Awareness and Education	Training sessions conducted	50 eco-credits per session

Source: author's own elaboration

Scoring and weighting process:

Initially, each practice is evaluated using the scores provided in table 10. These scores reflect the basic contribution of each practice to sustainability. However, since not all practices have the same level of difficulty, cost, or impact, we apply a weighting system to ensure fairness and accuracy in the eco-credit calculation. Each practice's score is multiplied by a weight that reflects various factors such as importance, cost, and impact. This weight is determined on a scale from 1 to 5, where experts assess how critical and challenging each practice is in reality.
Moreover, this system provides a transparent and structured methodology for assessing sustainability performance, allowing businesses to track their progress and compare their efforts against industry benchmarks. By creating an incentive structure that rewards meaningful and impactful sustainability actions, the eco-credit system serves as a catalyst for widespread adoption of eco-friendly practices, ultimately contributing to the long-term conservation and sustainable development of the Shouf region.

Real-World Application: Cezar Farmville Barouk Guesthouse:

Cezar Farmville Guesthouse in Barouk, Shouf, offers a practical example of how the blockchain-based eco-credit system can be implemented. The guesthouse applies a variety of sustainable practices, including energy savings of 6,000 kWh annually via LED lighting and efficient appliances. It harvests 15,000 liters of rainwater and maintains its plumbing to reduce water waste. Waste is managed through a 30% cut in single-use plastics, composting 1.5 tons of organic waste yearly, and a recycling system.

Socially and economically, the guesthouse sources 80% of its food and materials locally, with 60% being certified organic or fair trade. It hires local staff, partners with nearby businesses, and supports community reforestation and cultural events. Visitors also enjoy two annual cultural experiences to preserve heritage.

All these actions were evaluated using the eco-credit formula:

Eco-Credit = Base Score × Weight Factor,

Measured in units (kWh, liters, %, tons) and adjusted for impact, cost, and feasibility.

Final Eco-Credit Score Table – Cezar Farmville Guesthouse

#	Sustainable Practice	Implementation Summary	Metric/Scope	Base Score	Weight	Final Eco-Credits
1	Energy-saving technologies	LED & efficient appliances	6,000 kWh/year	6 × 100 = 600	4	2,400

2	Rainwater harvesting	Reuse for irrigation & maintenance	15,000 liters/year	1.5 × 75 = 112.5	2	225
3	Plumbing maintenance	Regular leak-checks	1 initiative/year	1 × 100 = 100	2	200
4	Reduction of single-use plastics	30% reduction achieved	30% reduction	3 × 150 = 450	3	1,350
5	Composting organic waste	Kitchen/garden composting	1.5 tons/year	1.5 × 50 = 75	2	150
6	Recycling program	Full recycling & sorting program	1 program	1 × 100 = 100	2	200
7	Local sourcing of products	80% from nearby producers	80% local sourcing	8 × 100 = 800	5	4,000
8	Fair-trade and organic product usage	60% of supplies certified	60% of supplies	6 × 100 = 600	4	2,400
9	Support for local culture/traditions	2 cultural experiences/year	2 programs/year	2 × 100 = 200	5	1,000
10	Employment of local residents	Local hiring policy	1 program	1 × 100 = 100	4	400
11	Collaboration with local businesses	2 formal partnerships	2 partnerships	2 × 100 = 200	5	1,000
12	Participation in community initiatives	2 social/environmental events/year	2 initiatives/year	2 × 100 = 200	5	1,000

Title: Annual Eco-Credit Assessment of Cezar Farmville Guesthouse Based on Implemented Sustainability Practices
Source: Hakim, H. (2025). Eco-credit scoring model for sustainable practices in the hospitality sector: Application to Cezar Farmville Guesthouse. Author's own elaboration.

The eco-credit scoring table for Cezar Farmville Guesthouse evaluates its sustainability efforts by combining measurable environmental outcomes with weighted factors that reflect each practice's impact and complexity. Each practice receives a base score derived from quantifiable metrics (e.g., energy saved, waste reduced) and is then multiplied by a weight to capture strategic importance and implementation difficulty. For example, Energy-Saving Technologies earned 2,400 eco-credits. The guesthouse saved 6,000 kWh annually through LED lighting and efficient appliances. Using the system's benchmark of 100 eco-credits per 1,000 kWh saved, the base score is 600. Given the significant upfront costs and long-term benefits, a weight of 4 was applied, multiplying 600 by 4 to reach 2,400 eco-credits.Other practices include rainwater harvesting (225 credits), plumbing maintenance (200), plastic reduction (1,350), composting (150), and a recycling program (200). The guesthouse excels in local sourcing, earning 4,000 credits due to sourcing 80% of products locally, weighted heavily for economic and environmental benefits. Additional areas include fair-trade product use, cultural support, local employment, business collaboration, and community initiatives, all weighted to reflect their sustainability impact.

Overall, the total 13,725 eco-credits highlight the guesthouse's deep integration of sustainability across operations and community engagement.

The reward system offers benefits in three main areas for Platinum Tier holders. First, Recognition & Certification includes official eco-certification, listing on the Shouf Biosphere Reserve's Green Accommodation map, and priority promotion in national sustainable tourism campaigns. Second, Financial and Operational Incentives provide free technical audits, access to sustainability grants, discounts on eco-friendly supplies, and reduced licensing fees. Third, Capacity Building & Market Advantage grants priority access to training workshops, opportunities to co-create eco-tourism packages, and the exclusive use of a Blockchain Verified Sustainability Badge to enhance visibility and attract eco-conscious travelers.

Tier	Eco-Credit Range	Example Rewards
Bronze	2,000–4,999	Social media mention, annual workshop invite
Silver	5,000–8,999	Green listing, 1-year supplier discount voucher
Gold	9,000–11,999	Certification, feature in official guide, training access
Platinum	12,000+	All above + technical audit, grants, and policy engagement

Title: Tiered Eco-Reward System for Guesthouses Based on Annual Eco-Credit Accumulation
Source: Hakim, H. (2025). Blockchain-based eco-reward system for incentivizing sustainable practices in Lebanese guesthouses. Developed by the author based on the eco-credit model.

This realistic system leverages non-monetary recognition, micro-financial support, and network-based advantages—which are often more accessible and impactful in Lebanon's current ecotourism ecosystem than large monetary rewards.

Conclusion:

Ecotourism in Lebanon, while rich in potential, continues to face deeply rooted structural and contextual barriers that hinder its contribution to sustainable development. As this article has shown, challenges such as governance fragmentation, economic instability, lack of clear standards, and limited environmental awareness undermine efforts to build an authentic and resilient ecotourism sector—particularly in critical areas like the Shouf Biosphere Reserve. In the face of mounting national crises and global disruptions such as COVID-19, Lebanon's path toward achieving the SDGs requires innovative, decentralized solutions that empower local stakeholders. The blockchain-based eco-credit system proposed in this study offers a practical mechanism for incentivizing sustainability, enhancing transparency, and aligning tourism practices with broader development goals. By rewarding measurable, verified actions and enabling traceable impact, this model can foster accountability and cross-sector collaboration. Ultimately, it positions ecotourism not just as a destination experience, but as a strategic tool for environmental stewardship and socio-economic resilience.

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"تمكين السياحة البيئية المستدامة من خلال تقنية البلوك تشين: نموذج قابل للتوسع للاعتمادات البيئية في المناطق المحمية – دراسة حالة محمية أرز الشوف للمحيط الحيوي، لبنان"

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البروفيسورة ليليان بركات

الملخص:

تُعدّ السياحة البيئية من الأدوات الفاعلة لتحقيق التنمية المستدامة، ولا سيما في المناطق الغنية بالتنوع البيولوجي والتي تعاني في الوقت نفسه من هشاشة مؤسسية واقتصادية. وفي لبنان، وعلى الرغم من الإمكانات البيئية والثقافية الكبيرة، لا تزال ممارسات السياحة البيئية تواجه تحديات بنيوية تعيق فاعليتها، من أبرزها عدم الاستقرار السياسي، والأزمة الاقتصادية، وضعف الحوكمة، وتجزؤ الأدوار المؤسسية، والاعتماد على التمويل الخارجي، إضافة إلى فجوات الثقة بين أصحاب المصلحة.

تهدف هذه الدراسة إلى تحليل التحديات التي تعيق تطوير السياحة البيئية في محمية أرز الشوف للمحيط الحيوي، واقتراح نموذج ابتكاري لتعزيز الاستدامة والشفافية. اعتمدت الدراسة منهجًا نوعيًا، حيث تم جمع البيانات من خلال 15 مقابلة شبه مهيكلة مع مجموعة متنوعة من الجهات المعنية، بما في ذلك الإدارات الحكومية، وإدارة المحمية، والبلديات، والمنظمات غير الحكومية، والقطاع الخاص. وأظهرت نتائج التحليل الموضوعي أن غياب آليات المساءلة، وضعف معايير التقييم البيئي، وافتقار الحوافز الفعّالة للممارسات المستدامة، تشكل عوائق رئيسية أمام مصداقية السياحة البيئية واستدامتها.

استجابةً لهذه التحديات، تقترح الدراسة نظامًا قائمًا على تقنية البلوك تشين لتوليد اعتمادات بيئية رقمية، يتم من خلالها تحفيز الممارسات المستدامة الموثقة عبر مؤشرات كمية قابلة للتحقق، مثل كفاءة الطاقة، وإدارة النفايات، وترشيد المياه، وحماية التنوع البيولوجي، والمشاركة المجتمعية. ويعرض البحث تطبيقًا عمليًا للنظام من خلال دراسة حالة لنُزل سياحي في منطقة باروك، يوضح كيفية قياس الجهود المستدامة ومكافأتها بشكل شفاف.

تؤكد النتائج أن تقنية البلوك تشين تمثل أداة واعدة لتعزيز الحوكمة البيئية، وبناء الثقة، ودعم التنمية المستدامة للسياحة البيئية في السياقات الهشة.

الكلمات المفتاحية: السياحة البيئية، التنمية المستدامة، البلوك تشين، نظام الاعتمادات البيئية، محمية أرز الشوف للمحيط الحيوي، لبنان.