

Landscaping Theory and Lean Tourism: Evidence from the World's Longest Natural Sea Beach

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ABSTRACT: The symbiotic relationship between landscape and tourism is fundamental, as both natural and man-made environments serve as primary drivers for visitor experiences and economic opportunities. This study explores the intersection of landscaping theory and Lean Tourism at Cox's Bazar, Bangladesh—the world's longest natural sea beach. By integrating aesthetic and environmental management, landscaping theory facilitates a visual-spatial presentation that enhances tourist appeal while promoting sustainable resource utilization. To evaluate the impact of strategic landscaping on Lean Tourism, this research employs a multifaceted framework. It utilizes Value Stream Mapping, Just-In-Time (JIT) systems, and the Stimulus-Organism-Response (SOR) model to examine how optimized spatial design minimizes waste and ecological footprints. Furthermore, the principles of Kaizen are applied to ensure continuous improvement in coastal management and community engagement. Data analysis was conducted using Structural Equation Modeling (SEM) and Path Analysis to determine how landscaping variables influence the efficiency and long-term viability of the tourism sector. The findings underscore the critical role of landscaping in creating a streamlined, value-driven destination that balances economic growth with the preservation of the coastal ecosystem.

KEYWORDS: Lean Tourism; Landscaping Theory; Stimulus-Organism-Response (SOR) Model; Just-In-Time (JIT) Systems; Value Stream Mapping; Path Analysis.

1. INTRODUCTION

Bangladesh's Cox's Bazar, which stretches between 120–155 kilometers along the Bay of Bengal, is the world's longest uninterrupted natural sandy shoreline (Chakroborty, Alam, et al., 2025). Millions of tourists visit this top location every year because of its golden dunes, glistening waves, and famous sunrises. The core of the region's tourism industry is made up of important hubs including Laboni Point, Kolatoli, and Inani Beach, as well as the natural beauty of Himchori National Park and St. Martin's Island (Sarker et al., 2019). However, coastal erosion, unchecked urban growth, sea level rise, and disruptive infrastructure projects like sea wall construction and land-based sediment displacement are currently causing substantial deterioration to this natural legacy (M. S. Islam, 2003). This study investigates the use of landscaping theory as a catalyst for lean tourism in order to alleviate these pressures. Landscaping theory goes beyond simple aesthetics, integrating cultural and functional design to optimize human perception and psychological well-being (Tatiyanantakul & Chindaprasert, 2024). When applied to a coastal context, it facilitates the creation of "enchanted" yet eco-friendly environments that balance tourist satisfaction with aggressive environmental conservation (M. M. Islam & Shamsuddoha, 2018). This approach is central to the "Lean" philosophy, which aims to eliminate "waste"—here defined as environmental degradation and social displacement—while promoting a high-value, low-impact sustainable blue economy (Cziesielski et al., 2021; Chakroborty et al., 2026). In order to maximize human perception and psychological well-being, landscaping philosophy integrates cultural and utilitarian design, going beyond simple aesthetics (Menatti & Rocha, 2016; Miah et al., 2025). When used in a seaside setting, it makes it easier to create "enchanted" but environmentally beneficial settings that strike a compromise between aggressive environmental conservation and visitor satisfaction (HAN, 2006). This strategy is essential to the "Lean" ideology, which aims to promote a high-value, low-impact sustainable blue economy while eradicating "waste"—here defined as environmental damage and social displacement (Bhasin & Found, 2021; Zhu et al., 2025). In order to assess the effectiveness of the coastal infrastructure, the study employs a strong operational framework. Value Stream Mapping is used to identify experiential bottlenecks, and Just-In-Time (JIT) systems are used to manage resource flow. Additionally, the Stimulus-Organism-Response (SOR) Model is utilized to decipher how

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particular landscape interventions (Stimuli) influence tourist psychology (Organism) and subsequent sustainable behaviors (Response). This study demonstrates how strategic landscaping transforms Cox's Bazar from a vulnerable mass-tourism site into a resilient, community-focused destination. Utilizing Structural Equation Modeling (SEM), the research validates integrating Landscaping Theory with Lean Tourism principles. Path coefficients indicate that optimized visual-spatial design acts as a direct environmental and behavioral catalyst rather than a passive aesthetic tool. Specifically, a significant positive path between spatial design and Value Stream Mapping (VSM) indicators proves that strategic zoning reduces visitor "motion waste" and spatial friction, organically lowering the ecological footprint. Furthermore, the Stimulus-Organism-Response (SOR) model reveals that lean landscape stimuli alter tourists' cognitive states, fostering sustainable behavioral responses and environmental stewardship. Finally, continuous Kaizen feedback loops enable iterative layout adjustments that continuously mitigate resource waste without substantial capital re-investment, effectively bridging economic viability with long-term ecological sustainability.

1.1 Objective of the Study

The main goal of this study is to assess the transformative potential of landscaping theory in promoting a lean tourism ecosystem at Cox's Bazar. To this end, the study is guided by the following four specific objectives: First, the study aims to identify and classify the critical determinants—such as socio-economic, environmental, and infrastructure-related factors—that most significantly influence the development of lean tourism in the region. Secondly, the study aims to analyze the existing ecological framework of the Cox's Bazar coastline to determine its resilience against current anthropogenic and natural stressors, such as coastal erosion and uncontrolled urban expansion. Third, the study looks into how lean tourism concepts like resource efficiency and waste reduction might improve the beach's overall landscaping development and aesthetic appeal. In order to provide a path for the development of sustainable, high-value, and low-impact tourism in Bangladesh's blue economy, the study finishes by developing a complete policy framework that integrates strategic landscaping with lean operations.

1.2 Study Gap

There is a substantial study gap concerning the incorporation of Lean Management principles into the architectural and ecological landscaping of coastal destinations, despite the expanding corpus of literature on coastal management and mass tourism. The environmental effects of climate change or the socioeconomic advantages of traditional tourism development are the main topics of current study on Cox's Bazar. Nevertheless, there is a dearth of empirical studies that investigate how Landscaping Theory might operate as a vehicle for Lean Tourism, particularly in terms of lowering "spatial and operational waste" and simultaneously improving visitor psychology. Additionally, although the Stimulus-Organism-Response (SOR) model and Structural Equation Modeling (SEM) are widely used in consumer behavior research, their application in assessing the intersection of lean efficiency and aesthetic landscape design in a South Asian coastal context is still largely unexplored. The majority of existing frameworks fail to bridge the gap between high-level sustainable theories and the technical, "Just-In-Time" infrastructure necessary for a resilient blue economy. This study fills this gap by using Value Stream Mapping and Path Analysis to provide a data-driven roadmap for moving from vulnerable mass tourism to a streamlined, eco-efficient landscape model.

2. LITERATURE REVIEW

In order to provide a theoretical framework for sustainable coastal development, this study's literature assessment incorporates the multidisciplinary fields of management science, landscape ecology, and environmental horticulture.

Theoretical Foundations: Lean Management in Tourism

Lean Tourism is the strategic application of lean management principles, which were first developed in the manufacturing sector, to the particular requirements of the tourism industry (Almomani et al., 2023). Fundamentally, this paradigm focuses on improving operational effectiveness and methodically eliminating "waste" (muda), which is defined here as any procedure or resource consumption that does not directly provide value to the visitor experience (Majerus & Abraham, 2025). Lean management aims to increase productivity, decrease operational overhead, and simplify service delivery by emphasizing continuous improvement (Kaizen) (Okpala et al., 2024). Important methodological tools, including Value Stream Mapping (VSM), enable the thorough examination of visitor flows and service bottlenecks, promoting a collaborative culture focused on providing exceptional, value-centric experiences that promote long-term sustainable growth (Tatiyanantakul & Chindaprasert, 2024).

The Nexus of Landscape Ecology and Tourism

Through intricate socio-ecological feedback loops, the environment, landscape, and tourism are inextricably intertwined. A crucial lens for analyzing a region's spatial characteristics and how they affect ecological processes is landscape ecology (Fenderson et al., 2020). This area tackles important problems including habitat fragmentation, biodiversity loss, and the movement of materials and energy across a coastal matrix by examining the interactions between natural and human-modified ecosystems. From an

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academic standpoint, the strategic planning required to improve landscape resilience is informed by environmental and ecological sciences, guaranteeing that human interventions—like tourism infrastructure—do not interfere with vital ecosystem functions (Dastgerdi & Kheyroddin, 2022).

Environmental Landscaping and Horticultural Integration

A key component of modern ecologically conscious landscape design is the integration of natural systems with engineered solutions. The planning and administration of environmentally sound green infrastructure that helps the tourism industry as well as the environment at large is the main focus of environmental landscaping principles (Monteiro et al., 2020; Chakroborty et al., 2025). A key component of this is horticultural science, which helps maintain the integrity of the coast by choosing and growing particular plants like turf grasses and salt-tolerant trees. Landscaping theory encourages a regenerative approach to tourist development in which the built environment's aesthetic and functional qualities assist to preserve and improve the underlying natural assets by coordinating man-made designs with natural processes (Ojo, 2024).

Operational Dimensions of Lean Tourism

The use of Lean Tourism in coastal locations is based on five fundamental operational parameters intended to balance economic production with environmental conservation. The Elimination of Waste (Muda), which entails the methodical identification and elimination of non-value-adding activities—such as excessive resource consumption or bureaucratic delays—to maximize service delivery, is at the heart of this framework. A dedication to continuous improvement, which is frequently operationalized through the Plan-Do-Check-Act (PDCA) cycle, complements this (Naughton et al., 2025; Mahnashi et al., 2023). This iterative technique makes it possible to continuously improve ecological and management tactics in a coastal setting in order to adjust to changing environmental conditions. Additionally, the approach ensures that all strategic actions are focused on improving the quality of the visitor experience by adopting a strict Customer Value Focus (Gopalan & Narayan, 2010). In order to facilitate a "frictionless" flow of logistics and visitor mobility, Operational Efficiency is integrated across the tourism supply chain, from sustainable procurement to final service delivery (Malkawi et al., 2025). Lastly, a Culture of Collaboration and Empowerment that encourages local stakeholders and staff to spot systemic inefficiencies and implement creative fixes is essential to the success of lean efforts (Zarbo, 2012). This collaborative strategy guarantees a robust and inclusive shift to a lean tourism economy.

Methodological Instruments of Lean Tourism

Cox's Bazar's shift to a lean tourist model requires the application of particular industrial engineering and management strategies tailored for the service industry. Value Stream Mapping (VSM), a diagnostic visualization tool that charts the whole lifespan of the tourist experience, is the most important of them (Seth & Dhariwal, 2017). Researchers and planners can find "bottlenecks" and environmental "muda" (waste) by mapping every touch point, from arrival and beach access to recreational activities (Alfayyadh, 2017). This highlights particular potential for operational and spatial optimization. The study looks at the use of Just-In-Time (JIT) systems in the coastal supply chain in addition to diagnostic tools. JIT, which is mostly used in the food service and hotel industries, focuses on matching supply to demand in real time (Proteek et al., 2026). This approach guarantees the delivery of fresh, high-quality items while reducing the carbon footprint associated with over-procurement and storage by drastically reducing "inventory waste" and ensuring that perishable resources are managed correctly. Lastly, the framework places a strong emphasis on standardization as a way to guarantee environmental hygiene and service consistency. The destination can minimize operational disruptions and uphold high standards of organizational cleanliness by implementing standardized work procedures for beach maintenance, waste collection, and facilities management. These uniform procedures act as the foundation for Kaizen (continuous improvement), offering a systematic setting where even little increases in productivity support the maritime ecosystem's long-term viability.

3. THEORETICAL FRAMEWORK

The integration of landscaping theory and operational efficiency requires a multi-disciplinary framework that bridges environmental design, consumer psychology, and management science.

Humanist Geography and the Landscaping Theory of Tourism

At the core of landscaping theory is Humanist Geography, a theoretical paradigm that examines how human beings invest geographic spaces with meaning, turning objective physical locations into subjective, value-laden places (Shah et al., 2023). Within this framework, landscapes are analyzed not merely as biophysical arrangements but as physical expressions of identity, culture, and history. In the context of destination management, this theory dictates that marketing and promotional strategies depend entirely on showcasing these curated landscapes to construct the dreams and fantasies that drive tourist interest (Debanath, 2025) (Chakroborty et al., 2025). The physical landscape serves as the primary medium through which visitors interact with a

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destination. The quality of this interaction—whether rooted in pristine natural features or rich cultural narratives—directly dictates the tourist's perceived rejuvenation and overall satisfaction (Gordon, 2018). Consequently, developing these tourism landscapes requires balancing environmental conservation with economic growth through adaptive management strategies.

The Stimulus-Organism-Response (S-O-R) Model in Tourism Psychology

To systematically map how these spatial and cultural meaning-making processes influence consumer behavior, this study adopts the Stimulus-Organism-Response (S-O-R) model. Formulated by Mehrabian and Russell in 1974, the S-O-R framework is a foundational principle in environmental psychology, consumer behavior, and user experience design (Erensoy et al., 2024). The model posits that external environmental influences do not directly trigger behaviors; rather, their impact is mediated by an individual's internal cognitive and emotional states.

Paradigm Shift: Traditional Cost Reduction vs. Lean Management

Historically, cost-reduction strategies within the tourism and hospitality sectors have focused heavily on variable labor costs, frequently resulting in wage reductions and staff downsizing. However, contemporary lean management theory highlights the operational deficiencies of focusing exclusively on labor exploitation to achieve financial efficiency (Nielsen & Kristensen, 2020; Chakroborty et al., 2025; Karim et al., 2022). Lean principles shift the focus toward controlling processes and activities efficiently, eliminating operational and environmental waste (*muda*), and fostering a culture of continuous improvement (*Kaizen*) (Okpala et al., 2024). This study investigates the feasibility and empirical impact of integrating the lean management model within the Cox's Bazar seacoast area of Bangladesh. Rather than treating operational efficiency and environmental conservation as conflicting goals, this paper demonstrates how lean tourism principles can enhance the ecological balance of Cox's Bazar Sea Beach while simultaneously improving its landscaping features.

3.1 Empirical Realities and Theoretical Foundations of the Landscape-Tourism Nexus

To establish a data-driven framework for Cox's Bazar, it is necessary to cross-examine current visitor metrics against the core tenets of Landscaping Theory. This alignment highlights how raw natural capital can be systematically managed to resolve operational bottlenecks and transition toward a lean tourism ecosystem.

3.1.1 Baseline Empirical Assessment: The Strain of Mass Tourism

Cox's Bazar faces extreme seasonal volatility, hosting two million peak-season visitors daily averaging 30,000 to 35,000, with annual arrivals projected to hit 15 million by 2030. While the 120-kilometer coastline drives strong commercial resilience despite weather and macroeconomic anomalies, systemic lean vulnerabilities generate substantial experiential waste. Critical service delivery defects—specifically in hygiene, sanitation, emergency response, transit layout, and information services—significantly undermine tourist satisfaction, necessitating optimized management frameworks to sustain this resilient asset class.

3.1.2 The Landscaping Theory of Tourism: A Conceptual Framework

The "landscaping theory of tourism" (frequently operationalized as the landscape-tourism nexus) conceptualizes the interconnected relationship between geo-ecological matrices, cultural topographies, and the tourism economy (Meneghello, 2021). Rather than treating geography as a static backdrop, this theory analyzes how landscapes function as the fundamental infrastructure for destination marketing, consumer desire, and regional identity (Saraniemi & Kylänen, 2011).

[Natural & Cultural Asset] → [The Tourist Gaze] → [Sensory Integration] → [Value-Driven Experience]

Within this framework, the physical environment is classified as a primary capital asset; for instance, a coastal region's prolonged sandy beach serves not merely as a geographic feature but as the foundational economic capital driving the local blue economy. Furthermore, the concept of the tourist gaze dictates that consumer perception actively shapes, modifies, and adds subjectivity to the physical terrain, transforming a raw biophysical landscape into a dynamic space of consumption, visual pleasure, and experiential value (Robinson, 2026). Landscaping theory expands this destination appeal beyond mere visual aesthetics by integrating multi-sensory dimensions—such as auditory wave mechanics and tactile sand quality—to create an immersive environment that stimulates consumer desire and emotional attachment (Tuominen, 2023). Concurrently, landscapes function as narrative vessels that communicate historical meaning, regional narratives, and ecological authenticity, which are vital for establishing a distinct destination identity that aligns with the tourist's self-identity (Lei et al., 2025). Finally, because tourism landscapes are highly dynamic and subject to continuous transformation, active and adaptive management is required to mitigate sustainability challenges while capitalizing on emerging economic opportunities.

3.1.3 Synthesis: Transforming Cox's Bazar through Lean Landscaping

A clear road forward is revealed by applying Landscaping Theory to the empirical data of Cox's Bazar. Traditional, unmanaged mass-tourism strategies cannot support the anticipated surge to 15 million visitors by 2030. The destination must employ strategic landscaping as a technique to address its service shortcomings in order to stop the devaluation of the beach's natural capital

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(Lukoseviciute & Panagopoulos, 2021). Tourist displeasure, for instance, can be directly addressed by rebuilding the physical landscape to incorporate integrated, high-hygiene sanitation corridors and conspicuous emergency stations. The "Tourist Gaze" can be dispersed from crowded hotspots toward underutilized areas by implementing lean concepts in the spatial architecture (Kadiu, 2024). This protects Bangladesh's most valuable natural resource's sensory, experiential, and ecological integrity.

3.2 Strategic Framework: Operationalizing Lean Tourism at Cox's Bazar

The systematic application of Lean Tourism principles to Cox's Bazar provides a pragmatic pathway to mitigate environmental degradation while maximizing regional economic yields. By treating the tourist journey as a structured value stream, management can transition the destination away from the pitfalls of unmanaged mass tourism toward a high-value, low-impact blue economy.

1. Diagnostic Foundations: Value Stream Mapping (VSM)

The operational baseline of this framework relies on Value Stream Mapping (VSM) to audit the holistic tourist journey—from initial arrival and regional transit to beach access and eventual departure (Tatiyanantakul & Chindaprasert, 2024). VSM functions as a diagnostic tool to expose systemic "muda" (waste), such as prolonged waiting times at transit hubs, disjointed pedestrian corridors, or underutilized public infrastructure. Identifying these friction points allows planners to re-engineer service delivery, ensuring that every touch point adds direct value to the visitor experience.

2. Targeted Waste Reduction (Muda)

To preserve the ecological integrity of the coastline, the Lean framework targets three primary waste vectors:

- **Environmental Waste:** The deployment of rigorous, standardized waste management protocols to eliminate plastic pollution and litter along the primary beach strata, directly preserving the destination's aesthetic and biological capital.
- **Overcrowding (Spatial Waste):** The implementation of strategic decentralization policies that actively divert tourist traffic from oversaturated nodes (e.g., Laboni Point) toward underutilized zones like Inani Beach and Himchori, optimizing spatial capacity across the 120-kilometer coastline.
- **Unnecessary Development (Structural Waste):** A strict policy shift away from speculative, resource-heavy concrete installations, prioritizing instead low-impact, sustainable infrastructure that integrates into—rather than disrupts—the natural maritime environment.

3. Value Maximization and Quality Control

In addition to eliminating trash, the model imposes stringent quality standards on all coastal services, with a focus on water-based recreation and hospitality safety to increase the destination's competitiveness internationally (Pásková et al., 2024). The pristine state of the golden beaches, the distinctive geological features at Inani Beach, and the serenity of the area's ecotourism trails are what tourists love most, and this customer-centric focus directly aligns management efforts with these aspects.

4. Continuous Adaptation (Kaizen) and Socio-Cultural Sustainability

Kaizen, or continual improvement fueled by multi-stakeholder feedback loops, is essential to this framework's endurance. Management may dynamically adjust infrastructure to changing ecological and market demands by collecting real-time data from tourists and nearby businesses. A fundamental dedication to socio-cultural sustainability, which structures the tourism industry to encourage genuine local interaction, supports this (Maziliauske, 2024). This actively protects the area's unique cultural legacy while ensuring that the financial advantages of the blue economy are shared fairly among the local population (Banu et al., 2024; Ahmed et al., 2023; Chakroborty, 2023).

4. THE ROLE OF LEAN TOURISM IN SUSTAINABLE LANDSCAPE MANAGEMENT

The application of lean concepts in coastal landscaping marks a paradigm shift from resource-heavy development to precision-based, regenerative practices. Centered on resource efficiency, this strategy methodically minimizes water and energy consumption while aligning tourism infrastructure with environmental conservation to preserve fragile local ecosystems, such as indigenous sand dunes and salt-tolerant flora (Luković et al., 2020). This transition is guided by sustainable landscape planning, which embeds ecological and cultural narratives into spatial design to secure the long-term biological and aesthetic viability of the coastline (Smithwick, 2022). This planning framework prioritizes carbon footprint reduction by promoting localized, "slow travel" experiences that mitigate mass-tourism emissions (Hannam & Gössling, 2026). Simultaneously, it integrates community involvement to empower local stakeholders as co-custodians of the landscape, thereby safeguarding cultural identity and ensuring equitable economic distribution (Queiros, 2023; Chakroborty & Sultana, 2023). Ultimately, this inclusive approach cultivates an enhanced tourist experience defined by deep emotional engagement with the region's natural and historical narratives, while providing a structured mechanism to balance the conflicting interests of commercial expansion and ecological protection within a sustainable blue economy.

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4.1 Strategic Applications of Lean Principles in Coastal Landscaping

The application of lean methods to coastal landscaping necessitates a fundamental reorientation in how physical space and cultural assets are utilized, balancing operational optimization with experiential quality to foster a resilient, high-value tourism model (Kritikos et al., 2025). Crucial to this transition is designing for scarcity, a concept that prioritizes high-efficiency, low-impact structures over resource-intensive, large-scale concrete developments. By implementing modular pavilions and permeable pathways, planners minimize the environmental disruption and material waste typically associated with conventional construction while seamlessly integrating infrastructure into the existing coastal morphology (Jayawardana et al., 2025). Furthermore, this framework counters generic, homogenized tourism growth by preserving and enhancing local identity, leveraging the unique geological and cultural characteristics of the region to elevate destination value without requiring artificial interventions (Talukder, 2025; Sultana & Chakroborty, 2022). This authenticity is reinforced through the utilization of local resources and traditional construction methods, which simultaneously reduces transportation-related carbon emissions and stimulates the regional economy. Finally, this lean design encourages deliberate, prolonged visitor engagement over high-turnover mass tourism by transforming the terrain into a catalyst for sustainable activities; through the strategic integration of walking paths, cultural immersion zones, and artisanal workshops, the landscape cultivates a deeper appreciation for the coastline's natural and historical value to ensure long-term product sustainability.

4.2 Core Principles of Lean Tourism and Landscape Integration

By coordinating spatial design with tourist-defined value—specifically, scenic beauty, cultural authenticity, and ecological connectivity—this study operationalizes lean principles to improve coastal landscape management. The framework systematically identifies and eliminates four critical dimensions of waste (*muda*) in order to maximize resource efficiency: excess inventory through just-in-time procurement, waiting times due to visitor bottlenecks, over-processing through excessive chemical and water maintenance, and unnecessary transportation through spatial reorganization. Lastly, by creating organized feedback loops between tourists and destination administrators, the framework incorporates Kaizen, or continual development. Management is able to constantly adjust to changes in the environment and changing visitor expectations thanks to this iterative data collecting. In the end, this methodical lean strategy removes operational and experience barriers, guaranteeing the maritime ecosystem's long-term socio-ecological sustainability and economic resilience.

4.3 Technological and Ecological Applications in Lean Landscaping

1. **Advanced Water and Resource Management:** Lean landscaping prioritizes native, climate-adapted flora to minimize artificial irrigation and maintenance costs (Mircea et al., 2024). Resource efficiency is optimized via sensor-based, "just-in-time" smart irrigation and integrated rainwater harvesting for non-potable applications, reducing municipal resource dependency (Hilaire et al., 2008).
2. **Waste Minimization and Circularity:** Aligning with circular economy principles, the framework utilizes locally sourced, recycled materials for hardscapes to lower procurement costs and logistical carbon footprints (Mohamed et al., 2024). On-site mulching and composting convert green waste into moisture-retaining soil additives (Stavi, 2020), while strategic planting configurations minimize biomass overflow and labor inefficiencies.
3. **Energy Efficiency and Passive Design:** Strategic tree canopy placement leverages passive cooling to decrease reliance on mechanical air conditioning (Kamal, 2012). This is supplemented by grid-independent renewable elements, including solar-powered lighting and digital signage.
4. **Experience Flow and Visual Management:** Lean principles optimize visitor mobility and value stream delivery:
 - **Wayfinding:** Intuitive trail design and standardized signage eliminate navigational waste and landmark congestion.
 - **Green Networks:** Integrated pedestrian and cycling corridors promote non-vehicular slow travel.
 - **Visual Management:** Standardized protocols prioritize labor allocation toward high-visibility zones based on real-time visitor feedback, maintaining destination quality efficiently.

4.4 Methodological Adaptation: Value Stream Mapping (VSM) in Service and Tourism Operations

Value Stream Mapping (VSM) serves as a foundational analytical instrument within a lean tourism framework to provide end-to-end visualization of operational pathways (Khalaf, 2024). By systematically differentiating between value-adding activities and non-value-adding waste (*muda*), VSM grants destination managers the operational transparency needed to deconstruct structural inefficiencies and purge hidden process bottlenecks (Dania, 2025). While historically localized within industrial manufacturing, recent cross-disciplinary adaptations demonstrate VSM's efficacy in streamlining highly variable service delivery systems (Shamim, 2025). When applied to tourism, this diagnostic lens enables accommodation providers and managers to minimize overhead expenditures and fortify core operational efficiency (Taheri et al., 2026). Consequently, capital and labor are directed exclusively

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toward activities that generate direct utility for visitors, thereby elevating the overall consumer experience. Ultimately, this paradigm requires systematic, longitudinal process analysis coupled with continuous tourist feedback loops to iteratively isolate emerging waste vectors and refine service operations.

5. METHODOLOGY

To empirically evaluate the intersection of landscaping theory and Lean Tourism principles, primary data was collected from domestic and international tourists visiting Cox's Bazar, Bangladesh. A non-probability purposive sampling technique was deployed to target respondents who were actively engaging with both the natural coastal landscape and the surrounding built hospitality environment. A total of 450 questionnaires were distributed across major beachfront zones (Laboni, Sugandha, and Inani beaches) during peak and shoulder tourism seasons. After screening for incomplete responses and outliers, 384 valid questionnaires were retained for final analysis, yielding a response rate of 85.3%. The minimum sample size was determined using the widely accepted rule-of-thumb for Structural Equation Modeling (SEM), which recommends a minimum observation-to-variable ratio of 10:1 or 15:1. With 25 manifest indicators across our latent constructs, our sample size of 384 far exceeds this threshold, ensuring sufficient statistical power and minimizing standard errors during maximum likelihood estimation. Structural Equation Modeling (SEM) is uniquely suited for this coastal tourism context due to its capacity to simulate multiple causalities and latent (hidden) variables simultaneously (Liu et al., 2025). Rather than evaluating landscape interventions—such as eco-resort redesigns or pedestrian zoning—in isolation, SEM analyzes how these distinct elements interact to dictate overall system efficiency. Complementing this, Path Analysis maps the direct and indirect dependencies linking specific landscaping variables to lean performance metrics like waste reduction and spatial optimization. Together, these analytical tools yield a statistically validated, data-driven framework demonstrating how strategic landscape architecture drives operational efficiency and sustainable growth along the Cox's Bazar coastline. The demographic profile of the final sample comprised 58% male and 42% female respondents, with the majority falling into the 22–45 age demographic (64%), reflecting the primary active domestic tourism market in Bangladesh.

5.1 Path Analytical Framework and Variable Classification

Path Analysis is an advanced multivariate statistical technique employed to examine, validate, and test complex structural relationships among a network of variables. By mapping both direct and indirect causal pathways within a hypothesized conceptual model, this technique allows researchers to discern how intermediary mechanisms transmit the effects of foundational inputs to ultimate outcomes, typically visualized through a structural path diagram. Within this study's analytical architecture, the variables are systematically categorized into three distinct operational classifications:

Exogenous Inputs	Intermediary Variables	Endogenous Outcomes
•Sociodemographic •Macroclimate •Edaphic Quality	•Biological (Resp.) •Built Environment	•Health Status •Ecosystem Quality

- **Exogenous (Independent) Variables:** These represent the foundational, uncaused inputs within the structural model. In this research, the exogenous vectors include sociodemographic profiles (age, gender, work status) alongside baseline biophysical and microclimatic indicators (air temperature, soil quality).
- **Intermediary (Mediating) Variables:** These factors act simultaneously as both dependent responses to exogenous inputs and independent drivers of final outcomes. The structural model identifies physiological mechanisms (respiration) and physical infrastructure (house structure) as the primary mediating channels.
- **Endogenous (Dependent) Variables:** These represent the final structural outcomes determined by the combined direct and indirect pathways of the model. The primary endogenous targets under investigation are macro-level health outcomes, localized environmental quality, and overall ecosystem stability.

By applying this path analytical taxonomy, the study empirically decodes how variations in baseline environmental and human demographic factors filter through physical and physiological intermediaries to shape the broader socio-ecological and public health landscape.

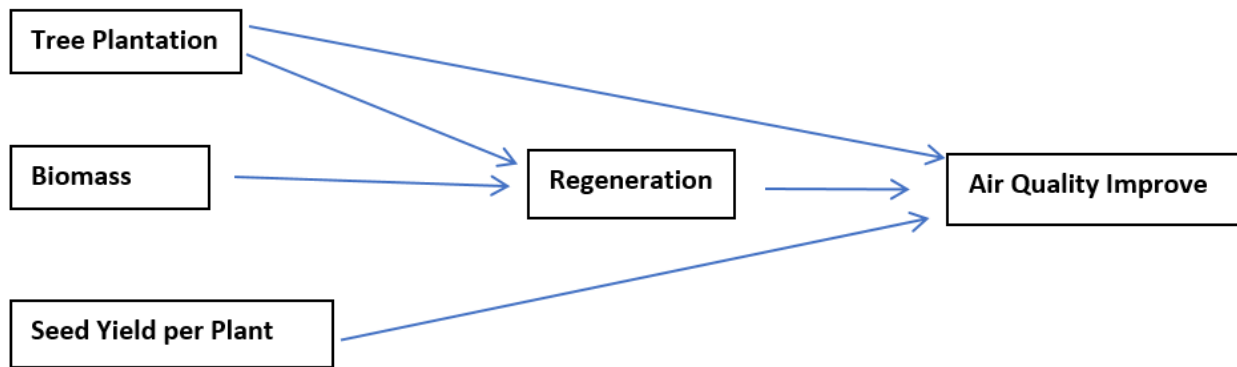


Figure 01: SEM of Air Quality Improve of Cox's Bazar Sea Beach

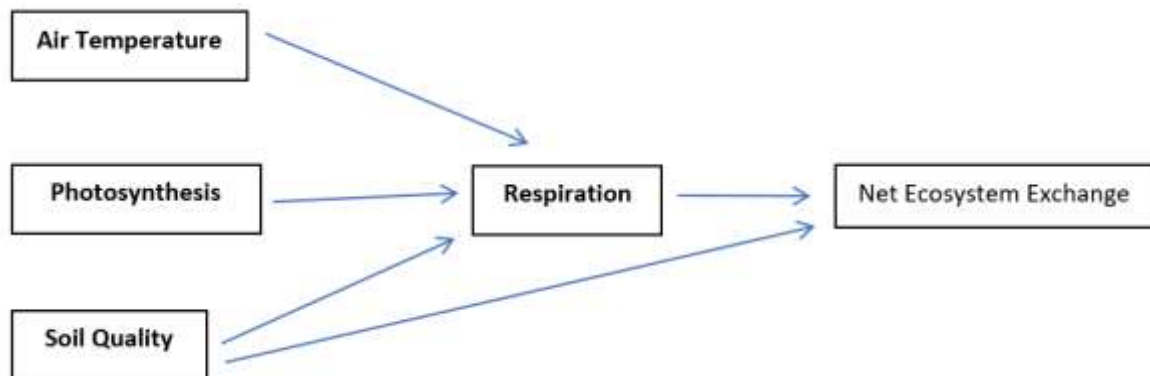


Figure 02: SEM of Ecosystem Change of Sea Beach

Basic use of structural equation modeling (SEM) in path analysis with mediation. The causal relationships include both direct and indirect effects. Where Respiration is a mediator that participates in the causal relations.

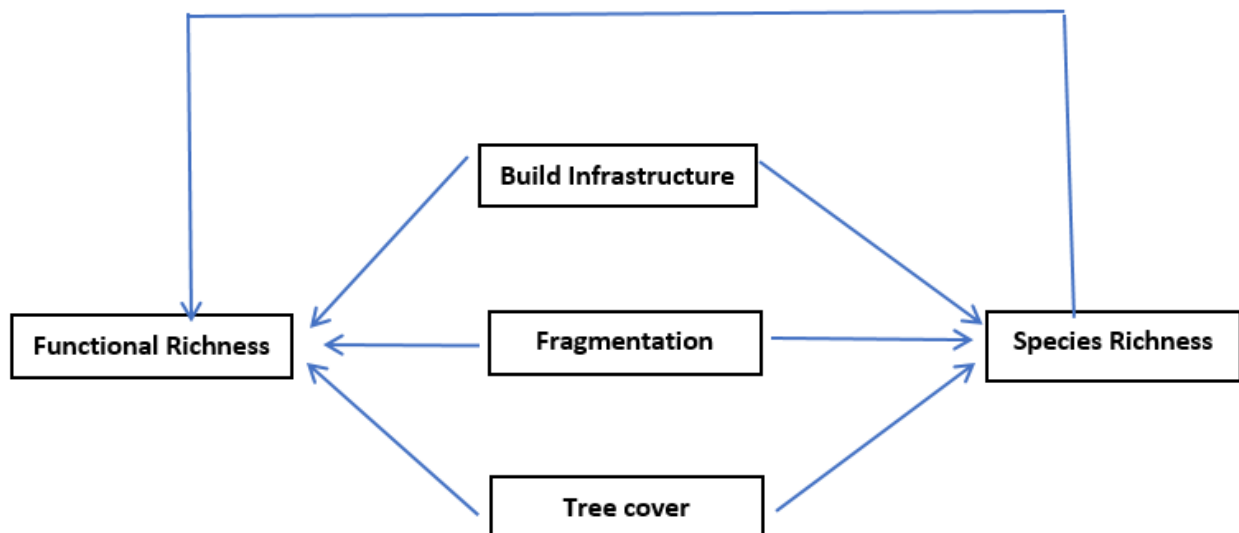


Figure 03: Structural Equation Model of Tree Plantation & Infrastructure Development of Sea Beach

Confirmatory Factor Analysis (CFA) is a statistical technique used to verify whether observed variables are consistent with a hypothesized model of latent variables (factors). It is a deductive approach, meaning that we begin with a theory or model and then test whether the data support it.

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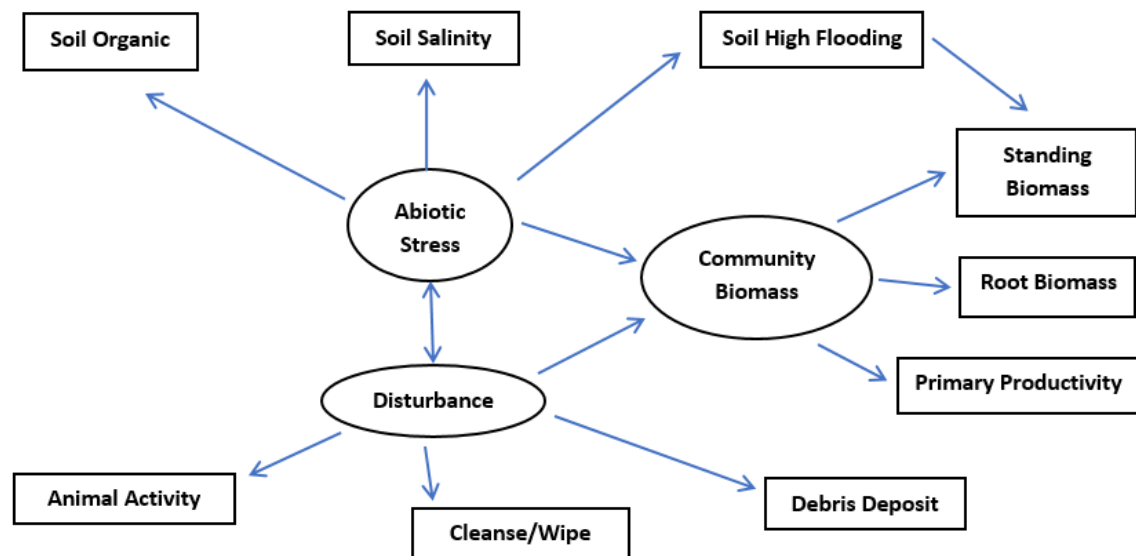


Figure 04: Conformity Factor Analysis of Beach Area.

Measurements of the hidden variables. This SEM measures abstract concepts (i.e. latent variables) in the ovals based on the observed variables.

Feedback Loop:

Cox's bazar Sea beach can be seen as a complex system with feedback loops where factors such as temperature, humidity, rain etc.

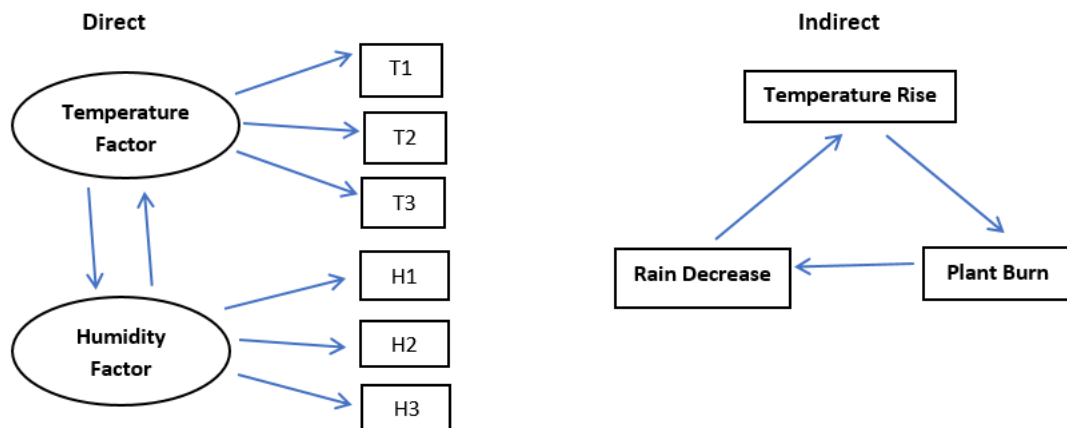


Figure 05: Feedback loop of Sea Beach Ecosystem

An example of an ecosystem analysis feedback loop. In SEM analysis, feedback loops are adaptable and can be either direct or indirect.

6. DATA PRESENTATION

As a designated Ecologically Critical Area (ECA), Cox's Bazar requires strict adherence to its established regulatory buffer zones to protect sensitive habitats. However, the landscape faces severe degradation from compounding anthropogenic and climate pressures. Critical threats include illegal natural resource extraction, unplanned urbanization, and climate change. These vulnerabilities are exacerbated by the rise of unregulated mass tourism, driven by a growing middle class and improved infrastructure access. This influx has caused severe overcrowding at high-density nodes, escalating boat traffic, and widespread environmental pollution (solid waste, noise, and light disruptions). By applying Lean Tourism theory, this study provides a systematic approach to minimizing these environmental impacts, offering a data-driven model to balance heavy tourist traffic with ecosystem preservation.

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Table 1: Area Distribution and Location of Different Restoration Activities.

Type of Activity	Activity Started	Location	Area(ha)
Forest Restoration	2018	Outside refugee camp	0.36
		Inside refugee camp	27.51
	2019	Outside refugee camp	298.23
		Inside refugee camp	66.53
Land Stabilization	2018	Inside refugee camp	9.33
	2019	Inside refugee camp	0.78
		Outside refugee camp	4.96
Reforestation	2018	Outside refugee camp	11.36
		Inside refugee camp	33.97
	2019	Outside refugee camp	38.08
		Inside refugee camp	40.12
Total			531.23

Landscaping Theory Analysis

Guided by Landscaping Theory in environmental management, the empirical data demonstrates a strategic progression from localized stabilization to landscape-scale ecological restoration. The spatial distribution of interventions reveals an adaptive management trajectory. Initial efforts in 2018 focused exclusively on stabilizing high-density refugee camp environments to mitigate immediate anthropogenic stress. By 2019, operations shifted primarily outside camp boundaries, reclaiming 341.27 ha. This transition established vital ecological buffer zones and biodiversity corridors, significantly enhancing regional landscape connectivity and watershed stability. In terms of land function integration, the restoration framework heavily prioritized long-term ecological sustainability. Combined forest restoration and reforestation initiatives comprised 516.16 ha, or approximately 97% of the total intervention area. This massive expansion of the vegetative canopy directly facilitates soil-carbon sequestration and biomass recovery. This effort was reinforced by targeted land stabilization (15.07 ha) to arrest soil erosion on degraded slopes. Temporally, the project experienced a 5.4-fold growth, accelerating from roughly 83 ha in 2018 to 448 ha in 2019. This sharp increase indicates a successful transition from a small-scale pilot phase to mature, resourceful, landscape-scale implementation. Ultimately, this integrated landscape management model balances ecological recovery with social resilience, offering mutual environmental and economic utility to both displaced populations and host communities.

Integrative Insights

Empirical data reveals a progressive landscape transformation scaling from localized rehabilitation to ecosystem-wide reforestation. Analyzed through Landscaping Theory and Lean Tourism Theory, this trajectory demonstrates sound ecological planning alongside efficient, participatory resource management that converts environmental restoration into non-extractive ecotourism. Ultimately, this dual-optimization framework ensures long-term socio-ecological sustainability and economic resilience for both displaced populations and host communities.

Dimension	Landscaping Perspective	Lean Tourism Perspective
Goal	Ecological restoration and resilience	Sustainable livelihood and tourism efficiency
Focus Area	Land cover, vegetation, erosion control	Human value creation and minimal environmental impact
2018–2019 Shift	Scaling from local stabilization to regional restoration	From community aid to self-sustaining green enterprise
Outcome	531.23 ha of rehabilitated landscape	Potential for eco-tourism and green jobs

Table 2: Land Degradation in Cox's Bazar South Forest Division (Areas are in ha.)

Location	Forest Type	Degradation			Other(Enhancement or No Change)	Total
		High	Medium	Low		
Inside camp	Non forest land	4	79	22	543	648
	Protected forest	5	56	4	101	165
	Reserved forest	484	701	25	616	1826
Within 1 KM from camp boundary	Non forest land	9	107	42	1533	1691
	Protected forest	2	32	8	220	262
	Reserved forest	315	411	349	2684	3760

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Within 1-5 KM from camp boundary	Non forest land	33	348	202	7742	8325
	Protected forest	3	64	38	1133	1237
	Reserved forest	173	536	930	14484	16122
5 KM further from the camp boundary	Non forest land	48	656	300	13338	14342
	Protected forest	12	200	166	4843	5220
	Reserved forest	38	279	542	13235	14094
Total		1127	3468	2625	60472	67692

Context Overview

The table represents how different types of forest land (Reserved, Protected, and Non-forest land) are impacted by degradation around a tourism camp.

Zone	Forest Type	Total Area (units)	Main Pattern
Inside Camp	Mostly Reserved Forest	1,826	Moderate degradation
Within 1 km	Reserved Forest dominant	3,760	High degradation
1–5 km	Non-forest & Reserved Forest	16,122 (Reserved) + 8,325 (Non-forest)	High degradation
>5 km	Non-forest & Reserved Forest	14,094 (Reserved) + 14,342 (Non-forest)	Some Stabilization but Still Degraded

Landscape Ecology Analysis

Applying landscape ecology concepts reveals a clear disturbance gradient radiating from settlements, where degradation peaks within the 1–5 km transition zone due to intense tourism, grazing, and fuel wood extraction (Ghazoul & Chazdon, 2017). This anthropogenic pressure decays with distance, creating a fragmented mosaic that varies across forest classifications. Reserved Forests suffer the highest degradation from severe encroachment and weak zoning enforcement, whereas Protected Forests exhibit insufficient buffering and Non-Forest Lands remain converted (Mishra & Agarwal, 2024). This selective pressure accelerates fragmentation, isolates patches, and degrades critical wildlife corridors into human-dominated edges, necessitating strategic connectivity restoration and dense vegetative buffering around high-impact tourism zones.

Lean Tourism Principles Application

Lean Tourism (derived from Lean Management) aims for value creation with minimal waste and impact — "doing more with less" for sustainable visitor experiences.

Lean Principle	Landscape Application	Action Recommendation
Value Identification	Focus on tourism that highlights ecosystem health as part of the experience.	Promote eco-guided experiences emphasizing conservation value.
Waste Minimization	Waste here = unnecessary ecological disturbance.	Limit camp sprawl, energy use, and off-trail activities.
Flow Optimization	Manage visitor flow to reduce peak congestion and degradation.	Implement visitor quotas and rotating use zones.
Continuous Improvement (Kaizen)	Regularly monitor land cover and visitor impact.	Use remote sensing to track degradation trends yearly.
Respect for People and Place	Involve local communities in conservation-based tourism.	Support community-managed buffer zones with eco-benefits.

Integrative Insights

Spatial-Zonal Management Approach

Zone	Management Focus	Lean Tourism Action
Inside Camp	Low-impact infrastructure; restore degraded patches.	Renewable energy, zero-waste operations, replanting native species.
Within 1 km	Critical buffer; needs strict regulation.	Visitor limits, controlled trails, local eco-guards.
1–5 km	Major degradation area — transition zone.	Develop community-based eco-tourism and reforestation incentives.
>5 km	Outer landscape; potential for ecosystem service recovery.	Support sustainable agriculture and conservation incentives.

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Summary Interpretation

Key Finding	Landscape Meaning	Lean Tourism Opportunity
Highest degradation within 1–5 km radius	Edge zone vulnerable to spillover	Zone-based visitor management
Reserved forests most impacted	Core habitat under stress	Reinforce protection, guided eco-access only
Non-forest land stable	Already modified	Channel tourism infrastructure here instead
Enhancement areas concentrated in non-forest land	Restoration potential	Use these zones for community-led tree planting

A gradient of spatial deterioration emanating from the camp is revealed by using landscape ecology, endangering the interconnectedness of the forest. The camp can transition from extractive to restorative tourism by using lean tourism, which minimizes waste (ecological disturbance), maximizes land usage, and encourages ongoing environmental improvement.

Table 3: Category wise land use distribution of HNP from 1977-2017

Land use category	Land use (A) in 1977 Area (ha)		Land use (B) in 1977 Area (ha)		Land use (B) in 2017 Area (ha)	
	1977	% of land	1997	% of land	2017	% of land
Agriculture	0.00	0.00	0.00	0.00	20.12	1.16
Degraded land	127.44	7.38	182.43	10.56	359.86	20.83
Settlement	0.00	0.00	0.00	0.00	81.99	4.74
Dense Forest	1058.04	61.23	1257.75	72.79	528.62	30.59
Light Forest	542.52	31.40	287.82	16.66	735.17	42.54
Water body	0.00	0.00	0.00	0.00	2.24	0.13
Total	1728.00	100	1728.00	100.00	1728	100.00

Overview of Land Use Change (1977–2017)

Land Use Category	1977 (ha)	%	1997 (ha)	%	2017 (ha)	%	Change 1977–2017 (ha)	Change (%)
Agriculture	0.00	0.00	0.00	0.00	20.12	1.16	+20.12	+1.16
Degraded land	127.44	7.38	182.43	10.56	359.86	20.83	+232.42	+13.45
Settlement	0.00	0.00	0.00	0.00	81.99	4.74	+81.99	+4.74
Dense forest	1058.04	61.23	1257.75	72.79	528.62	30.59	–529.42	–30.64
Light forest	542.52	31.40	287.82	16.66	735.17	42.54	+192.65	+11.14
Water body	0.00	0.00	0.00	0.00	2.24	0.13	+2.24	+0.13
Total	1728	100	1728	100	1728	100	—	—

Landscape Analysis

Applying landscape theory to long-term spatial data from 1977–1997 to the final observation period reveals a structural shift from a cohesive natural matrix to a fragmented, human-dominated environment. This is characterized by a sharp forest transition: thick forest cover decreased from 61.23% to 30.59%, while light forest canopy increased from 31.4% to 42.54%, indicating severe canopy degradation and biomass loss alongside limited secondary regeneration. Concurrently, damaged land surfaces tripled from 127.44 ha to 359.86 ha, demonstrating severe topsoil erosion and lost vegetative cover. These ecological disturbances are driven by anthropogenic expansion; built-up settlement footprints rose from a zero-baseline to 4.74% of the terrain, while agricultural land expanded to 20.12 ha. Additionally, 2.24 ha of artificial water bodies emerged, reflecting deliberate spatial hydro-landscaping for irrigation and ecotourism. Ultimately, this structural fragmentation amplifies edge effects and severs habitat connectivity, undermining local biodiversity and ecosystem services.

Land Tourism Theory Interpretation

Landscape tourism theory highlights a critical trade-off between environmental degradation and emerging recreational assets. While dense forest canopy loss and a tripling of degraded land (muda) diminish the natural capital necessary for high-value ecotourism, structural transitions—such as light canopies, artificial water bodies, and managed agriculture—generate niche opportunities for low-impact nature tourism, bird watching, and agri-tourism. Furthermore, although expanding built-up settlements improve regional infrastructure and accessibility, unmanaged horizontal growth threatens coastal ecosystems. These

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dynamics necessitate a comprehensive landscape planning framework to strategically balance economic expansion with ecological integrity.

- **Targeted Reforestation:** Active restoration of degraded zones to rebuild the region's natural aesthetic capital.
- **Low-Impact Infrastructure:** Prioritization of eco-friendly tourism designs over resource-heavy concrete installations.
- **Spatial Conservation Zoning:** Strict regulatory separation between core environmental conservation buffers and designated tourism development zones.
- **Participatory Governance:** Direct integration of local host communities into land-use management to ensure equitable socio-economic returns and long-term destination stability.

Summary of Theoretical Insights

Theoretical Lens	Key Observation	Implication
Landscape Ecology	Fragmentation and land degradation are increasing.	Biodiversity loss and ecosystem imbalance.
Land Tourism Theory	Shift from pristine forest to mixed-use landscape.	Reduced natural tourism value; new agro-ecotourism opportunities.
Sustainability Perspective	Human activities expanding (settlements, agriculture).	Need for integrated land-use and tourism planning.

A patchwork of degraded land, communities, light forest, and small agricultural areas replaced the forest-dominated terrain between 1977 and 2017. From the standpoint of the landscape and tourism, due to land deterioration and forest loss, the area's natural aesthetic and ecological value has decreased. However, if sustainable landscape management and restoration techniques are applied, diverse land use creates new chances for agricultural-ecotourism and community-based tourism.

Table 04: Land use change assessment of HNP based on time frame data (1977-2017)

Land use category	Land use Change (B-A): 1977-1997			Land use Change (C-B):1997-2017			Land Use Change(C-A): 1977-2017		
	Changed area(ha)	% Change	Annual rate of change (ha)	Changed Area (ha)	% Change	Annual rate of change (ha)	Changed Area (ha)	% Change	Annual rate of change (ha)
Agriculture	0.0	0.0	0.0	+20.1	0.0	0.0	+20.1	0.0	0.0
Degraded Land	+55.0	+43.1	+2.7	+177.4	+97.3	+4.9	+232.4	+182.4	+4.6
Settlement	0.0	0.0	0.0	+82.0	0.0	0.0	+82.0	0.0	0.0
Dense Forest	+199.7	+18.9	+10.0	-729.1	-58.0	-2.9	-529.4	-50.0	-1.3
Light Forest	-254.7	-46.9	-12.7	+447.3	+155.4	+7.8	+192.6	+35.5	+0.9
Water body	0.0	0.0	0.0	0.0	0.0	0.0	+2.2	0.0	0.0

Note: “+” denotes increase and “-” denotes decrease of magnitude of change of land use category in different period of Cox’s bazar sea beach.

Landscape-Level Interpretation

A structural shift from a cohesive natural environment to a fragmented, human-dominated landscape is revealed by the long-term spatial dynamics of the coastal matrix. A 50% decrease in thick forest cover (-529.4 ha) and a 182% increase in degraded land surfaces (+232.4 ha) are the hallmarks of this ecological collapse. This inverse trajectory suggests that habitat connection is being disrupted and edge effects are growing due to structural fragmentation. While the increase of built-up communities (+82 ha) illustrates the increasing demographic and infrastructure challenges this coastal zone faces, the extension of light forest stands (+192.6 ha) further highlights persistent canopy deterioration. Integrating Lean Tourism Theory provides a resource-efficient framework to counteract this ecological simplicity and strike a balance between environmental preservation and commercial growth. Destination managers can implement targeted zoning and corridor restoration to remove spatial waste (muda) and create buffer zones around high-density regions by assessing the landscape through an operational lens. This approach transforms growing light forests and artificial water bodies into non-extractive resources for low-impact ecotourism, like bird-watching corridors and eco-trails. In the end, this approach ensures long-term ecological and economic resilience for the area by converting environmental restoration into green livelihood opportunities through local labor and participatory governance (Kaizen).

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Landscape Function and Ecosystem Services:

Land Use	Ecosystem Service Change	Interpretation
Dense Forest ↓	↓ Carbon storage, ↓ biodiversity	Loss of primary ecosystem services
Light Forest ↑	Partial habitat replacement	Secondary growth, less ecological stability
Degraded Land ↑	↓ Productivity, ↑ erosion	Negative environmental indicator
Settlement ↑	↑ Infrastructure, ↓ natural cover	Anthropogenic footprint expansion
Water Body ~	Stable water resources	Some hydrological balance retained

Table 05: Predicted Land use change assessment of HNP for time frame (2017-2037)

Land use category	Predicted Land Use in 2037		Land Use in 2017		Predicted Land Use Change :2017-2037		
	Area (ha)	% of Land	Area (ha)	% of Land	Changed Area (ha)	% Change	Annual rate of change (ha)
Agriculture	24.14	1.40	20.12	+0.20	+4.02	+20.00	+0.20
Degraded Land	395.35	22.88	359.86	+1.77	+35.49	+9.86	+1.77
Settlement	98.39	5.69	81.99	+0.82	+16.40	+20.00	+0.82
Dense Forest	382.79	22.15	528.62	-7.29	-145.83	-27.59	-7.29
Light Forest	824.64	47.72	735.17	+4.47	+89.47	+12.17	+4.47
Water Body	2.69	0.16	2.24	+0.02	+0.45	+20.00	+0.02
Total	1727.98						

Overview of the Land Use Change (2017–2037)

Land Use Category	2017 Area (ha)	2037 Predicted (ha)	Change (ha)	% Change	Trend
Agriculture	20.12	24.14	+4.02	+20.00%	Moderate increase
Degraded Land	359.86	395.35	+35.49	+9.86%	Increase (negative indicator)
Settlement	81.99	98.39	+16.40	+20.00%	Increasing urbanization
Dense Forest	528.62	382.79	-145.83	-27.59%	Significant loss
Light Forest	735.17	824.64	+89.47	+12.17%	Moderate recovery (conversion from dense to light)
Water Body	2.24	2.69	+0.45	+20.00%	Stable/increasing slightly
Total	1727.98	1727.98	—	—	—

Landscape Theory Analysis

A systematic structural change from a contiguous natural matrix to a human-dominated, semi-natural system is revealed when landscape theory is applied to the empirical data. A distinct fragmentation sequence, characterized by a 12.17% increase in light forest stands and a 27.6% decrease in thick forest cover, has jeopardized landscape balance and function. This change shows that open, less bio diverse regions are gradually replacing closed-canopy forests. A 9.86% rise in degraded land and a 20% expansion in agricultural zones support this structural decrease, demonstrating that human land-use intensification is directly causing environmental stress in the region. The ecological health and interconnectedness of the landscape are significantly weakened by this structural change. The surviving wildlife corridors are broken up by the shrinkage of dense forest habitats, isolating local species and reducing the resilience of the ecosystem as a whole. Although there was a 20% rise in small water bodies, this growth is insufficient to counteract the larger loss of core forest cover.

Cumulatively, these dynamics demonstrate a clear spatial transition pattern: Dense Forest → Light Forest → Degraded Land → Agriculture/Settlement. This structural trajectory is highly characteristic of developing, tourism-dense regions where rapid economic expansion systematically outpaces environmental conservation controls.

Lean Tourism Theory Analysis

Applying Lean Tourism Theory to observed spatial dynamics provides a framework for maximizing resource efficiency and mitigating structural waste (muda) in coastal environments. The documented loss of dense forest cover alongside a 9.86% increase in degraded land underscores significant institutional inefficiencies and environmental overexploitation. To counter this resource

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depreciation, a lean tourism strategy prioritizes compact land stewardship—favoring low-impact eco-lodges, green infrastructure, and forest-based recreation over resource-intensive urban expansion.

Simultaneously, managing the 20% growth in built-up settlement areas requires compact, high-efficiency infrastructure design. Rather than permitting unmanaged horizontal urban sprawl, lean frameworks advocate for optimizing existing physical assets. By integrating sustainable agroforestry and community-based ecotourism into emerging light forest templates, destination managers can convert modified landscapes into protected buffer zones and functional eco-trails. Ultimately, this approach reclaims degraded land into productive natural capital, preserving critical coastal ecosystems while generating local economic value.

Integrated Interpretation

Observation	Landscape Theory View	Lean Tourism Perspective	Sustainable Strategy
Dense forest loss	Ecological degradation, fragmentation	Wasted ecological capital	Forest restoration & eco-tourism integration
Increased degraded land	Reduced resilience, soil erosion risk	Resource inefficiency	Reclamation & reforestation programs
Settlement expansion	Urban encroachment	Potential overdevelopment	Promote green architecture & zoning
Agricultural increase	Cultural landscape persistence	Potential for agro-tourism	Organic farming & landscape-based tourism
Slight water body increase	Improved hydrology if protected	Opportunity for nature-based recreation	Wetland conservation & eco-parks

Strategic Policy Recommendations

This study operationalizes lean management principles to maximize resource efficiency, eliminate operational waste (*muda*), and preserve the Cox's Bazar coastline. Utilizing Value Stream Mapping (VSM), the methodology audits beach-cleaning workflows to eliminate non-value-added procedures and bottlenecks. Localized workflows are streamlined via target-driven Kaizen events to reduce physical overburden (*muri*), while an Andon-signaling Visual Management System provides real-time pollution tracking. Complex ecological disruptions are mitigated using A3 problem-solving, alongside Standardized Work Procedures and a localized 5S framework. Ultimately, this approach decentralizes operational control, fostering continuous stakeholder-driven improvement (Kaizen) to ensure a sustainable, high-value maritime destination experience. To restore ecological balance and maximize operational efficiency, future coastal planning must implement an integrated resource framework based on five specific interventions:

- **Ecological Connectivity and Restoration:** Fragmented dense forest patches must be reconnected by establishing dedicated ecological corridors. Concurrently, degraded lands should be rehabilitated using mixed native vegetation managed through community stewardship frameworks to stabilize topsoil and recover lost biomass.
- **Spatial Regulation and Zoning Controls:** Growth-boundary zoning policies must be enforced to halt horizontal settlement sprawl, shielding the region's Ecologically Critical Area (ECA) and establishing protective vegetative buffer zones around highly sensitive habitats.
- **Sustainable Infrastructure and Livelihoods:** Destination management should prioritize compact, low-impact lean tourism infrastructure that minimizes spatial and resource waste (*muda*). By embedding non-extractive agro- and forest-based tourism models into these zones, the framework generates sustainable community income while actively preserving the regional landscape matrix.

7. RESEARCH IMPLICATIONS

By combining manufacturing optimization with environmental design, this study expands Lean Tourism beyond hospitality administrative domains into outdoor ecological resource management, contributing to the literature on sustainable tourism. The study employs Structural Equation Modeling (SEM) to quantify Landscaping Theory in a Stimulus-Organism-Response (SOR) framework, providing empirical evidence of how spatial aesthetics serve as a structural stimulus (S) that motivates sustainable behaviors (R) via psychological orientation (O). This approach provides policymakers and destination managers with practical operational tactics. During high seasonal surges, destination management organizations (DMOs) can use Just-In-Time (JIT) logic to dynamically assign mobile security and garbage units. To lessen environmental hotspots, administrative organizations like the Cox's Bazar Development Authority (CDA) might also use physical Value Stream Mapping (VSM). Lastly, creating localized public-

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private Kaizen circles encourages ongoing, inexpensive micro-improvements, ensuring long-term ecosystem resilience, spatial efficiency, and destination cleanliness.

8. CONCLUSION

This study establishes a comprehensive Lean-Landscaping framework for Cox's Bazar sea beach, balancing operational efficiency, ecological preservation, and tourism-driven economic growth. Utilizing Value Stream Mapping (VSM), the research identifies and eliminates spatial and operational waste (muda), such as resource-intensive management and uncoordinated sanitation workflows. The framework replaces high-input artificial designs with native, salt-tolerant flora—specifically sea oats and ornamental grasses—to optimize resource allocation and enhance shoreline resilience against environmental stressors. Concurrently, the strategic integration of native rock formations and natural dune configurations provides bio-inspired erosion control while establishing distinct, aesthetically cohesive boundaries for visitor zoning. From a circular economy perspective, the framework converts waste management into a self-sustaining financial model. Highly accessible, clearly zoned disposal facilities facilitate source-separation of recyclables, generating revenue that directly funds continuous beachfront maintenance (Kaizen). To mitigate visitor-induced ecological friction, low-impact pathways guide pedestrian traffic away from fragile habitats without compromising the recreational experience. Grounded in local community participation, this paradigm merges lean efficiency with indigenous ecological knowledge. While tailored to the unique spatial dynamics of Cox's Bazar, the underlying framework holds significant global generalizability for high-density, ecologically vulnerable coastal tourism management. The structural pathways identified are directly transferable to analogous South Asian coastal corridors, such as Mirissa in Sri Lanka or the inhabited islands of the Maldives, where finite spatial capacities and acute infrastructure-ecosystem conflicts mirror those of Cox's Bazar. Future cross-comparative research applying this multifaceted model can systematically evaluate how variances in municipal governance and community-led Kaizen initiatives alter the efficacy of Just-In-Time (JIT) resource utilization and spatial waste minimization globally.

AUTHORS CONTRIBUTION

Tamal Chakroborty (0000-0002-9673-2446) & A. K. M. Ashiqur Rahman (0000-0002-7633-9065): All authors have contributed equally and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this manuscript.

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