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Sustainable Development of Landscape Architecture from the Perspective of Energy and Environment Management

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Abstract: *-* A major concern in the field of landscape architecture is sustainable development. The goal of this strategy is to provide design solutions that satisfy current demands without jeopardizing the capacity of future generations to satisfy their own. The viewpoint of energy and environmental management is crucial for achieving sustainable development in landscape architecture. Energy management is essential to landscape architecture because it involves resource efficiency, reducing energy usage, and integrating renewable energy sources. It includes incorporating strategies like passive solar design, proper material selection, and the use of green infrastructure systems. These practices not only promote eco-friendly designs but also reduce the cost of maintenance and operation in the long term. Environmental management focuses on preserving and enhancing the natural environment through sustainable land use practices.

Keywords: Sustainable Development, Landscape Architecture, Environment Management, Energy Consumption, Incorporation, Eco-Friendly

1. Introduction

The subject of landscape architecture deals with the planning, designing, and administration of outdoor areas, emphasizing the creation of useful and sustainable settings [1]. As people's awareness of the effects of climate change and the depletion of natural resources has grown, the discipline of landscape architecture has shifted its focus to include energy and environmental management themes [2]. Energy management in landscape architecture is the deliberate use of resources to lower energy consumption and greenhouse gas emissions. It can be done by using energy-efficient building materials and methods and by designing with renewable energy sources like solar panels and wind turbines [3]. An appropriate planting design can assist control outdoor temperature and lessen the need for artificial heating and cooling. Landscape architects may help promote sustainable practices and lessen the carbon footprint of their projects by putting these tactics into practice [4]. In landscape architecture, environment management entails incorporating natural ecosystems into the design process. It involves choosing suitable native plants and trees that need little care, which lowers the need for pesticides, fertilizers, and water [5]. The natural water cycle can be less negatively impacted by urbanization by implementing stormwater management techniques like rain gardens and green roofs, according to landscape architects [6]. In addition to offering aesthetic and practical advantages, outdoor spaces also support a more sustainable and healthy environment since landscape architecture integrates energy and environmental management concepts [7]. In general, the viewpoint of energy and environmental management in landscape architecture demonstrates how this area is vital to tackling climate change issues and encouraging environmentally friendly lifestyle choices. Developing and maintaining outdoor areas that are both practical and aesthetically pleasing requires careful consideration of landscape architecture [8]. Every landscape architecture project should be centered around the idea of sustainability. Reducing the adverse effects on the environment, making effective use of resources, and designing environments that can adjust to changing circumstances are all

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components of sustainable design [9]. It necessitates a thorough comprehension of environmental processes in addition to the application of sustainable materials and methods that lower waste and energy usage [10]. In order to promote renewable energy sources and lower energy use, landscape architects are crucial [11]. It can be accomplished by designing with energy-efficient elements and renewable energy technology as wind turbines, solar panels, and green roofs [12]. For instance, carefully placing trees and other vegetation can reduce the demand for air conditioning and provide natural shade, both of which lower energy use [13]. In many places of the world, water shortage is a serious issue, hence landscape architects need to be proactive in including water conservation into their designs [14]. It entails implementing rainwater gathering systems, creating drought-resistant native plants, and creating effective irrigation systems [15]. In addition to conserving this essential resource, effective water management lowers energy consumption by requiring fewer energy-intensive water pumping and treatment procedures. The following constitutes the paper's primary contribution:

• Eco-friendly Design: In order to promote sustainable design principles that give energy and environmental management first priority, landscape architecture is essential. By strategically arranging flora, utilizing organic materials, and integrating eco-friendly technologies, landscape architects can lower a site's energy usage, lessen the impact of the urban heat island, and enhance the quality of the air and water.

• Mitigation of Climate Change: Given the growing threat posed by climate change, landscape architecture has emerged as a crucial instrument for reducing its consequences. The architecture of urban and natural landscapes can be made more resilient to extreme weather events, assist reduce carbon emissions, and boost biodiversity by including green infrastructure and sustainable systems.

• Green Building Certification: Achieving green building certification for projects has also been greatly aided by landscape architecture. Landscape architects can help a building become more sustainable and energy-efficient overall by working with engineers and architects. This can result in certifications like BREEAM (Building Research Establishment Environmental) or LEED (Leadership in Energy and Environmental Design).

The next chapters make up the remainder of the research. The most current research-related efforts are described in Chapter 2. The suggested model is explained in Chapter 3, and the comparative analysis is covered in Chapter 4. Ultimately, chapter 5 presents the findings, and chapter 6 discusses the study's conclusion and future directions.

2. Related Words

The Rough-based sets-based Ordinal Priority Approach, as described by Deveci, M., et al.[16], is a technique for assessing the accomplishment of Sustainable Development Goals (SDGs) in relation to sustainable mining. It prioritizes the goals according to their relative significance in advancing sustainability in the mining industry, taking into account a variety of performance metrics. Mengarelli, F. et,al.[17] have discussed The integration of renewable technologies in an Alpine heritage village promotes sustainable development by reducing carbon emissions and promoting eco-tourism. It can include implementing solar panels for energy efficiency, using geothermal heat pumps for heating and cooling, and promoting local biodiversity through sustainable agriculture practices. It creates a more environmentally friendly and self-sufficient community. Hoang, K. V. et al.[18] have discussed how Preserving and promoting cultural heritage values not only helps maintain a country's unique identity and history but also contributes to its economic, social, and environmental sustainability. It attracts tourism, boosts local economies, promotes social cohesion and inclusivity, and supports environmental conservation efforts. It also safeguards valuable knowledge and traditions for future generations. According to Pouresmaieli, M., et al. [19], meticulous strategic planning is necessary to guarantee effective resource usage and reduce environmental impact when integrating renewable energy and sustainable growth in the mining industry. Reducing carbon footprints, introduacing sustainable practices into mining operations, and putting renewable energy systems into place can all help achieve this. This strategy encourages prudent resource management and the sector's long-term viability. To evaluate the interdependent links between these systems in the region, Qin, J., et al.[20] have developed The Comprehensive evaluation and sustainable development of water, energy, food, and ecological systems in Central Asia. The results of this assessment will guide the creation of sustainable development plans that will enhance food and water security, encourage resource efficiency, and protect Central Asia's natural equilibrium. In order to assess the ecological and economic effects of urban waterfront landscapes, Jiang, G., et al. [21] claim that the Environmental Sustainability Study of urban waterfront landscapes combines the Life Cycle Assessment (LCA), Emergy Analysis, Carbon Footprint Analysis, and Artificial Neural Network method. This method assists in determining sustainable management strategies for these locations. Social value in the built environment, according to Raiden, A., et al. [22], is the benefit a project or development has over the community, including improving service accessibility or creating jobs. Organizational learning is the process of continuously improving and changing internal practices inside a corporation in response to changing external conditions. Urbanization and the Sustainable Development Goals (SDGs) are intimately related, as Chen, M., et al.[23] have argued. Urban areas are essential to attaining sustainable development. Sustainable development goals (SDGs) aim to guarantee sustainability in terms of the environment, economy, and society. The constructed environment is crucial to accomplishing these objectives. The SDGs' emphasis on ending poverty, improving health and well-being, and creating sustainable cities and communities has a direct impact on the opportunities and issues brought on by urbanization. Foroughi, R., et al. [24] have addressed the subject of environmental protection through sustainable land management, or the long-term maintenance of the health and productivity of natural resources through land usage. The implementation of sustainable farming practices, protection of biodiversity, and management of land use are necessary to halt environmental degradation and promote environmental conservation. By encouraging innovation, teamwork, and efficiency, industry 5.0, society 5.0, and smart cities and villages together can aid in the achievement of sustainable development goals, claim Kasinathan, P., et al. [25]. Artificial intelligence, the Internet of Things, and renewable energy are examples of disruptive technologies that can be used to build inclusive, sustainable solutions that improve the economy, the environment, and society at large. Following the pandemic, Song, M., et al. [26] discussed how China's internet economy has been essential to promoting sustainable development. It has improved accessibility to essential services, increased the efficiency of the supply chain, and made remote employment possible. Furthermore, the nation's reliance on digital technologies has contributed to green growth and the reduction of carbon emissions. N. Saqib et al. [27] have talked about This framework suggests a process for creating SDGs (sustainable development goals) with an emphasis on the green transition through the use of digital technologies. In order to prioritize initiatives and identify essential indicators for reaching the SDGs, a quantile-based methodology is employed. It can assist in directing resource allocation and policymaking in the direction of a more digital and sustainable future. According to Feng, Y. et al. [28], conserving urban heritage must manage scarce resources, strike a balance between contemporary growth and the preservation of ancient structures, and adjust to shifting social, economic, and environmental circumstances. In order to solve these issues from a sustainable development perspective, long-term viability, equity, and resilience must be prioritized. Industrial ecology is a systems-based approach that encourages the effective use of resources, the decrease of waste and pollution, and the development of circular economic activities, according to Awan, U. et al. [29]. By supporting environmentally conscious and sustainable economic operations, maintaining sustainable supply chains, and encouraging sustainable consumption patterns, it is consistent with the sustainable development aim of responsible consumption and production. Green entrepreneurship, defined as starting and running a business that minimizes its negative environmental impact and promotes sustainable development, has been covered by Tien, N. H., et al. [30]. This idea has received a lot of attention in Vietnam. It has the ability to completely alter the business landscape by fostering social responsibility, addressing environmental issues, and accelerating economic growth.

Table 1: Comprehensive Analysis

Authors	**Year**	**Advantage**	**Limitation**
Device, M., et. al [16]	2022	The rough sets based approach allows for the consideration of multiple factors and their interdependencies, providing acomprehensive evaluation of SDGs for sustainable mining.	Rough sets may not capture complex interrelationships among SDGs, leading to oversimplification andpotential bias in the evaluation process.

Mengarelli, F. et. al [17]	2024	Integration of renewable technologies in an Alpine heritage village can reduce its carbon footprint and promote sustainable practices for future generations.	The high costs associated with integrating renewable technologies may be too expensive for smaller, economically disadvantaged communities.
Hoang, K. V. et. al [18]	2021	Preserving and promoting cultural heritage values can attract tourism, boost economy, and enhance cultural diversity, leading to sustainable development of the country.	One limitation is that it can be expensive and resource-intensive to properly preserve and promote cultural heritage values.
Pouresmaieli, M., et. al [19]	2023	Reduced carbon footprint and environmental impact, leading to improved public image and stakeholder trust, while enhancing long-term sustainability and profitability.	Renewable energy solutions may be difficult to integrate into mining operations due to their high upfront costs and lengthy payback times.
Qin, J., et. al [20]	2022	One advantage is that it promotes integrated planning and decision-making for the efficient and equitable use of resources in the region.	Difficulties in obtaining accurate and up-to-date data due to limited resources and political tensions among Central Asian countries.
Jiang, G., et. al [21]	2024	finds the most sustainable and effective way to use resources in order to reduce harmful effects on the environment and advance long-term sustainability.	Possible limitation: Inability to accurately predict unforeseen environmental changes or events that may affect the sustainability of urban waterfront landscapes.
Raiden, A., et. al [22]	2021	The integration of social value and organisational learning promotes sustainable development and creates positive impact for communities, organizations, and the environment.	Lack of clear metrics to measure social value, limited spread of organizational learning, and difficulty in achieving SDGs due to complex and interconnected issues in the built environment.
Chen, M., et. al [23]	2022	Identifying interlinkages can help address diverse issues simultaneously, leading to more effective and efficient approaches in achieving sustainable development.	It may be difficult to accurately measure and quantify the specific impacts of urbanization on achieving certain Sustainable Development Goals.
Foroughi, R., et. al [24]	2024	Ecosystems stay healthy, supporting plant, animal and human life, reducing the risk of environmental degradation and promoting sustainability.	Difficulty in implementing and enforcing regulations consistently, especially in developing countries with limited resources and technology for monitoring and compliance.
Kasinathan, P., et. al [25]	2022	Sustainable development can result from resource efficiency and increased productivity brought about by cutting-	Sustainable development can result from more productive and resource-efficient usage of

		edge technology.	cutting-edge technologies.
Song, M., et. al [26]	2022	Enhanced online platforms and e-commerce enable increased economic activity and resilience in the face of disruptions.	One limitation is the potential for a digital divide, where certain groups and regions may be left behind in accessing and benefiting from digital resources.
Saqib, N., et. al [27]	2023	Increased speed and efficiency in tracking progress and identifying areas of improvement, leading to more targeted and effective implementation of sustainable development efforts.	The framework may not account for unique local contexts and may not be applicable globally.
Feng, Y. et. Al [28]	2024	Synergy between preservation and sustainable development goals leads to responsible and resilient conservation of urban heritage sites.	Balancing preservation needs and modernization goals may lead to conflict and compromises in heritage conservation practices.
Awan, U. et. al [29]	2022	Minimizes waste and promotes resource efficiency through the integration of industrial and natural systems.	One limitation of industrial ecology is that it requires significant coordination and collaboration between different industries, which can be difficult to achieve.
Tien, N. H., et. Al [30]	2023	Green entrepreneurship promotes sustainable development, leading to a healthier environment and creating new market opportunities for businesses.	Limited access to resources and investment for green startups, hindering their growth and impact on the overall business landscape.

- Lack of integrated design approach: One of the critical issues in landscape architecture is the lack of an integrated design approach that addresses both energy and environmental management. Often, these two aspects are seen as separate entities, leading to a fragmented approach to design.
- Limited focus on sustainable materials and practices: Landscape architecture often relies on traditional materials and practices, which may need to be more sustainable or energy-efficient choices. There needs to be a greater focus on using sustainable materials and incorporating design elements that promote energy conservation.
- Insufficient understanding of energy and environmental principles: Many landscape architects may need a more substantial background or understanding of energy and environmental principles, resulting in suboptimal design decisions that do not fully consider these factors.

The pressing need to solve the world's environmental and social concerns has led to a substantial increase in attention towards sustainable development in recent times. Even though the idea has been around for a few decades, it is becoming more and more clear how original it is technically. Economic growth is frequently given priority over social inequality and environmental deterioration in the traditional approach to development. Sustainable development, on the other hand, is concentrated on identifying long-term solutions that strike a balance between economic, social, and environmental factors.

2. Proposed system

A. Construction diagram

- **Harvest of raw materials :**

Harvesting raw materials is a crucial process in many industries, as it involves extracting natural resources from the earth to be used in producing various goods and services. This process typically involves several steps and requires specialized equipment and techniques to ensure these resources' efficient and sustainable extraction. In this paragraph, we will delve into the technical details of the operations involved in harvesting raw materials. The first step in this process is exploration and site preparation.

As a result, the outcomes of exergy assessments are contingent upon the reference environment that is provided, much of which is modeled after the real local environment.

$$Gh = Q(V - V_0) - T(f - f_0) + M_y(\eta_y - \eta_{y0}) \tag{1}$$

$$P(H) = j\frac{H+i}{H+d}, \quad j \neq 0, H \geq 0 \tag{2}$$

where U, L, and T stand for the parameter X's upper limit, lower limit, and threshold, respectively.

This involves conducting surveys and studies to identify potential sources of raw materials. Geologists and engineers use specialized equipment such as ground-penetrating radars and seismic surveys to locate deposits of minerals, metals, and other resources. Once a potential site is identified, it is further evaluated for its economic viability, accessibility, and environmental impact. Site preparation may involve clearing vegetation, building access roads, and setting up infrastructure for transportation and processing. Next, the actual extraction of raw materials begins with drilling and blasting. This process involves using powerful drills to bore holes into the ground and then filling them with explosives. These explosives are carefully placed to break up the rock or soil and allow easier extraction. The type and amount of explosives used are carefully controlled to minimize environmental impact.

- **Production of materials :**

Production of materials is a complex process that involves multiple steps and operations to create a usable and functional product. This process typically starts with sourcing raw materials, followed by processing and refinement, and ends with the final product being ready for distribution and use. The first step in the production of materials is the sourcing of raw materials. This can involve various methods, including mining, drilling, or harvesting from natural sources. The quality and type of raw materials significantly influence the final product and must be carefully selected and sourced to ensure the desired properties are achieved.

$$P(h) = \frac{(O-R)(O-V)}{(O+R-2V)h + OV + RV - 2RO} \tag{3}$$

$$q_b = \frac{(O_b - R_b)(H_b - T_b)}{(O_b + R_b - 2V_b)H_b + O_b + R_bV_b - 2O_bR_b} \tag{4}$$

Once the raw materials have been obtained, the next step is the processing and refinement stage. This involves transforming the raw materials into a usable form through various operations such as heating, mixing, cutting, pressing, or chemical reactions. Different materials require different processing methods depending on their properties and intended use. Quality control measures are implemented during the processing stage to ensure the materials meet specific standards and specifications. This includes conducting tests and inspections to detect any defects or inconsistencies in the materials. The materials may undergo additional refining processes or be discarded if any issues are found.

- **Transportation :**

Transportation is crucial in moving people and goods from one place to another. It is a complex system that involves various modes, infrastructure, and regulations to ensure safe and efficient mobility. Using various kinds of transportation is one of the core functions of transportation. Road, rail, air, water, and pipeline are a few of these. Every mode serves a certain function and has distinct qualities of its own. Air transportation is more expedient and better suited for extended distance travel, whereas road transportation is primarily utilized for short distances and to reach isolated locations. Heavy and bulky commodities are often transported by rail and water, whereas liquid and gas are transported by pipelines. The following figure 1 displays the construction diagram.

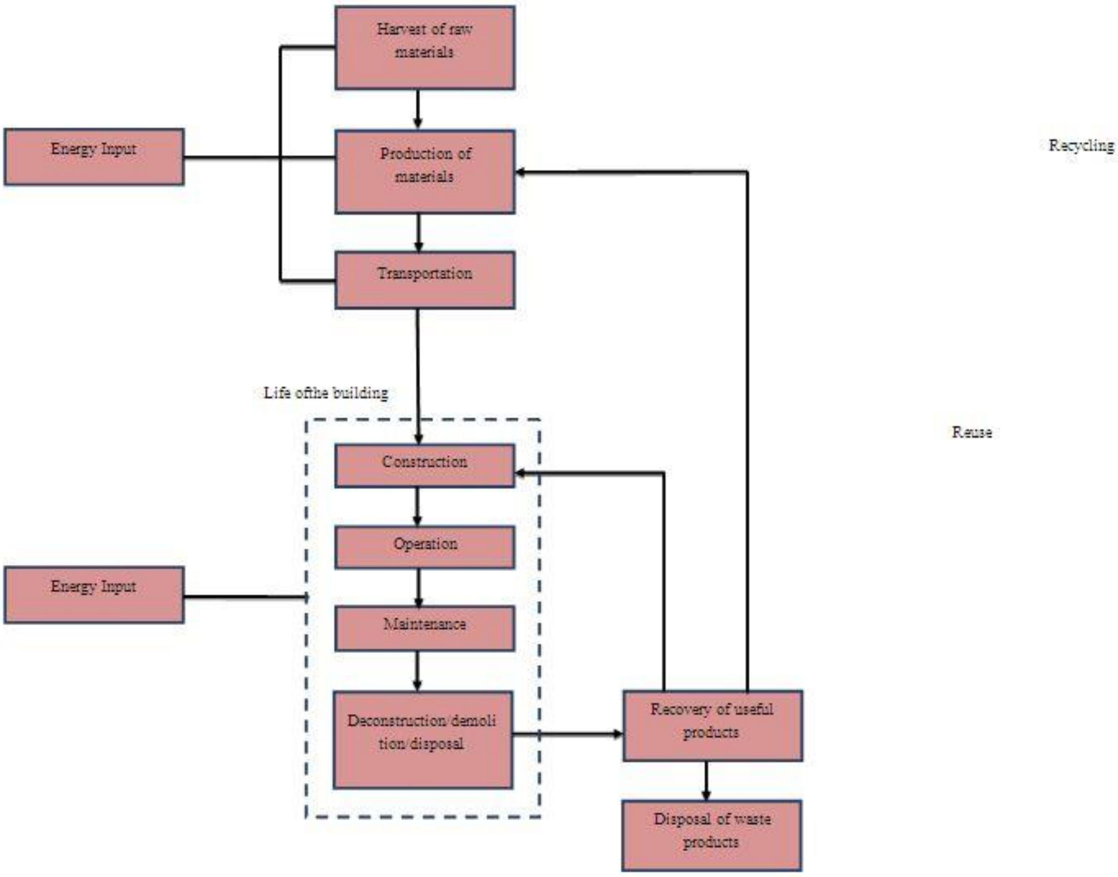

Fig 1: Construction diagram

The operation of transportation also involves the development and maintenance of transportation infrastructure. This includes roads, railways, airports, seaports, and pipelines. The construction and maintenance of these infrastructures require significant investments and are critical for the smooth operation of transportation. For instance, a well-maintained road network ensures the efficient movement of goods and people by reducing travel time and increasing safety. In addition to the physical infrastructure, transportation also relies on various supporting systems and services. This includes fuel stations, toll booths, logistics services, and navigation systems.

- **Energy Input :**

Energy input is an essential component of many industrial and manufacturing processes since it powers the tools and machines that are required. It describes the quantity of energy, whether heat, electricity, or mechanical power, that is given to a system. To put it another way, energy input is the fuel that enables a system or machine to run and carry out the intended task. Electricity is typically the main energy input source. This is due to the fact that electricity is a convenient and generally accessible source of energy that is easily generated and transferred. Furthermore, depending on the requirements of the system, electricity can be readily transformed into other types of energy, such as mechanical power or heat.

$$\left(0.5\sin\left(\frac{\pi}{m}\right)\sum_{b\neq a}\left(q_b-1\right)\left(q_a+1\right)\right)\times\frac{m!}{2}\times\frac{2}{m\left(m-1\right)} \tag{5}$$

The areas of all the regular outer polygons (n − 1)!/2 having side lengths of two units can be computed as

$$0.5\times4\times m\times\frac{\left(m-1\right)!}{2} \tag{6}$$

Next, the following ratio is calculated to determine the value of FPPSI:

$$Q=\frac{\sum_{b\neq a}^{b,a}\left(Q_b+1\right)\left(Q_a+1\right)}{2m\left(m-1\right)} \tag{7}$$

where S is the synthetic indicator's value, which can be standardized to account for the level in the hierarchy that is immediately above. The synthetic indicator's value is the sum of the values for all indicators at a lower level.

The energy input required for any operation depends on various factors, such as the equipment's type and size, the process's nature, and the desired output. For instance, heavy-duty machines and equipment require higher energy input than smaller, less complex systems. Similarly, processes that involve high temperatures, such as smelting or welding, require a higher energy input to achieve the desired results.

- **Maintenance :**

Maintenance ensures that equipment, facilities, and other assets are in good working condition and can perform their intended functions. In order to achieve this, maintenance operations involve various tasks and procedures designed to prevent breakdowns, extend the lifespan of assets, and reduce risks. The first step in maintenance operations is planning. This involves developing a maintenance schedule or plan that outlines the specific tasks and procedures that must be performed on each asset. The schedule considers factors such as the age of the asset, its expected lifespan, and the manufacturer's recommendations for maintenance. Once the plan is in place, the next step is to conduct routine inspections.

The consistency check of comparisons is used by AHP because pairwise comparisons might be highly subjective. Equations (1) and (2) demonstrate the calculation of CI and CR, respectively

$$DB=\left(\lambda_{\max}-m\right)/\left(m-1\right) \tag{8}$$

$$\det\left(X\right)=\frac{\partial^2 P}{\partial H^2}\frac{\partial^2 P}{\partial k^2}-\left(\frac{\partial^2 P}{\partial_H\partial_k}\right)^2 \tag{9}$$

Regular inspections allow maintenance teams to identify any potential issues or signs of wear and tear before they develop into more severe problems. These inspections may include visual checks, measurements, and tests to ensure the asset functions as it should. The maintenance team will move on to corrective maintenance if any issues are identified during an inspection. This involves repairing or replacing faulty parts or components to restore the asset to its optimal state. Corrective maintenance may be planned or unplanned, depending on the nature of the issue.

- **Recovery of useful products :**

Recovery of useful products is a process that involves extracting valuable materials from waste products or by-products of industrial processes. This operation is an efficient way to minimize waste and reduce the consumption of natural resources. This paragraph will discuss the various steps and technologies involved in recovering valuable products. The first step in this process is the collection and sorting of the waste materials. This is a crucial stage as it determines the quality and quantity of the recovered products. Various methods, such as manual sorting, magnetic separation, and sieving, can be used to sort different waste materials.

DXX and DXY reflect the processing outcomes. The specific processing approach involves processing the box filter and convolution image. It's expressed specifically in Eq. 3.

$$\det\left(X\right)=C_{HH}C_{kk}-\left(C_{hk}\right)^2 \tag{10}$$

For example, plastic waste can be sorted based on its type and color for efficient recycling. Once the waste materials are sorted, the next step is to break them down into smaller components. This is typically done through mechanical shredding or grinding, which reduces the size of the waste and makes it easier to extract valuable products. Different types of shredders and grinders are used depending on the type of waste being processed. After the waste has been broken down, other separation techniques are used to extract the valuable materials. These techniques include physical, chemical, and biological processes such as filtration, distillation, and extraction.

- **Disposal of waste products:**

Disposal of waste products is a critical operation that involves the safe and responsible management of materials that are no longer needed or useful. It is essential in maintaining a clean and healthy environment, preventing pollution, and protecting public health. The first step in the disposal of waste products is collecting and transporting the materials to designated facilities. This is usually done by waste management companies, which have the necessary equipment and trained personnel to handle different types of waste. The collection process involves sorting the waste into various categories, such as recyclable, hazardous, and non-hazardous, as this determines the proper disposal method. Once the waste is collected, it is transported to a disposal facility, which can take various forms depending on the type of waste. One standard method is landfilling, where waste is buried in a designated area and covered with soil layers to prevent environmental contamination.

Errors will always be introduced by the box filter employed in the surf algorithm. Consequently, Eq. 3 can be changed to

$$\det\left(X\right)=C_{hh}C_{kk}-\left(0.9*C_{hk}\right)^2 \tag{11}$$

Finding an ideal 3 × 3 homography matrix is the first step towards determining the ideal parameter matrix that satisfies the requirements when employing the RANSAC algorithm to remove mismatch and maximize the identified data points.

The location of landfills is carefully chosen to minimize the impact on surrounding communities and the environment. For hazardous waste, specialized treatment facilities are used to neutralize or destroy the harmful substances before disposal safely. This process involves various techniques, such as chemical treatment, incineration, or physical/ biological methods, depending on the nature of the waste.

B. Functional working model

- **Community Ecotourism :**

Community ecotourism is a type of responsible tourism that promotes sustainable development and conserves natural and cultural resources within a local community. It involves the local community actively managing and guiding tourists to achieve balance in environmental, social, and economic sustainability. In this paragraph, we will provide a deeper understanding of the operations of community ecotourism by looking at the different stages involved. The first stage of community ecotourism is the planning and development phase. This typically involves the local community identifying their natural and cultural resources and determining how they can be sustainably utilized for tourism. The functional block diagram has shown in the following fig.2

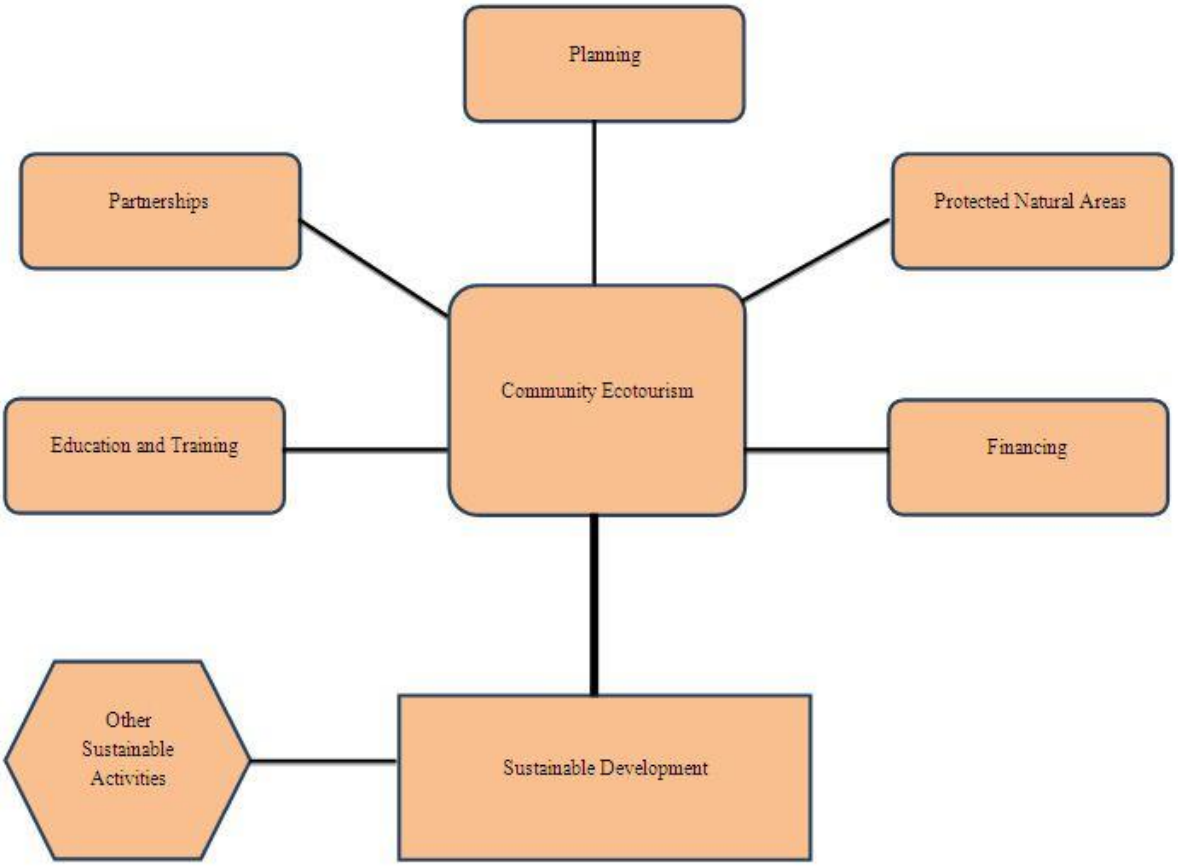

Fig 2: Functional block diagram

This may include conducting resource and impact assessments, developing community-based tourism management plans, and establishing partnerships with external stakeholders such as government agencies and tour operators. Once the planning stage is completed, the implementation phase begins. This involves the actual operation of ecotourism activities within the community. One significant aspect of community ecotourism is the active involvement of the local community in hosting and guiding tourists.

$$y = \frac{\log(1-f)}{\log(1-z^n)} \tag{12}$$

For the calculation model, a minimum of 4 samples (m) are required, and Equation 6's confidence level (P) is set at 0.995. The percentage of internal points in all samples is denoted by W.

A weight with adaptive inertia is one that fulfills the following formula: Iteratively decrease the weight from τ max to τ min after starting at τ max.

$$\omega(v) = \omega_{\max} - \frac{Bv}{Max\,\mathrm{int}\,er} \times (\omega_{\max} - \omega_{\min}) \tag{13}$$

- **Protected Natural Areas :**

Protected Natural Areas (PNA) refer to designated geographical regions designated by governments or other authorities to protect and conserve natural resources and biodiversity. These areas may include national parks, wildlife reserves, marine parks, and other conservation zones. The primary purpose of PNAs is to preserve and safeguard the natural environments and ecosystems within their boundaries. This involves several vital operations that work together to achieve the overall goal of protecting and promoting biodiversity. One of the most critical operations within PNAs is the establishment of rules and regulations that dictate what activities can and cannot take place within the protected area.

$$\begin{cases} d_1(v) = (d_{1p} - d_{1b}) \dfrac{Bv}{Maxlter} + d_{1b} \\ d_2(v) = (d_{2p} - d_{2b}) \dfrac{Bv}{Maxlter} + d_{2b} \end{cases} \tag{14}$$

The adaptive inertia weight is time-dependent and nonlinear, therefore the equation becomes:

$$\omega(v) = \omega_{\max} - \left(\frac{Bv}{Max\,\mathrm{int}\,er}\right)^m \times (\omega_{\max} - \omega_{\min}) \tag{15}$$

$$P(H) = Sgn\left\{\sum_{b=1}^{m} j_b * k_b \left[Y(h_b, h) + i*\right]\right\} \tag{16}$$

These rules may include restrictions on hunting, fishing, logging, and other potentially harmful activities. These regulations are designed to minimize human impact and disturbance on the natural environment, allowing it to thrive and remain balanced. Another essential operation is the enforcement of these rules and regulations. This is typically done by park rangers, who are responsible for monitoring and patrolling the PNA to ensure that visitors and locals abide by the established rules and regulations. This helps to prevent illegal activities and maintain the integrity of the protected area.

- **Education and Training :**

Fundamental procedures like education and training are designed to give people the competencies, information, and abilities needed for both professional and personal growth. It provides a route to employment, further education, and total economic and social emancipation. The first stage of education and training is the identification of learning needs. This involves thoroughly assessing the target audience and their specific learning requirements. Factors such as age, background, and existing knowledge are considered to create a customized and effective learning plan.

B * is the classification threshold, and the formula's summation is only achieved on the support vector.

The energy usage per capita indicator was also included in the final evaluation for dimension D1.

$$\frac{G}{f(D_a)} = \frac{\sum_{i=1}^{3} G_i + \sum_{v=1}^{3} G_v + G_e + G_c}{f(d_a)} \tag{17}$$

$$ESV = \sum_{b=1}^{m} \left(J_b \times TD_b \right) \tag{18}$$

$$ESV = \sum_{b=1}^{m} \left(J_b \times TD_{bp} \right) \tag{19}$$

Next, instructional design is carried out to determine the most appropriate methods, techniques, and materials for the learning process. This involves selecting the proper learning styles, technologies, and instructional strategies to deliver the content effectively. The implementation of the learning plan follows, including the actual delivery of the educational content. This can be done through various methods, such as classroom instruction, online learning, or hands-on training. Technology has dramatically enhanced the delivery of education and training, making it more accessible and interactive. Evaluation is an essential component of training and education because it helps teachers assess how well their lessons are working and how far their students have come. Numerous tools are used to accomplish this, including assignments, projects, assessments, and hands-on demonstrations.

- **Sustainable Development :**

Sustainable development is an all-encompassing approach to achieving economic growth that preserves the environment and promotes social advancement for both the current and future generations. Its basic tenet is striking a balance between present needs and future generations' ability to meet their own demands. This can be achieved by actions and policies related to the economy, environment, and society. Resource management, or the best use of available resources, is the foundation of sustainable development. In order to achieve this, sustainable patterns of production and consumption are encouraged, waste and pollution are reduced, and resources are saved for later use. This lessens the detrimental effects on the environment and guarantees the availability of resources for future generations.

Rather of using the inner product procedure, the kernel function is presented as follows:

$$Y\left(h_b, h_a\right) = \varphi\left(h_b\right)^V \varphi\left(h_a\right) \tag{20}$$

Kernel functions are defined as radial basis functions and are utilized as follows:

$$y\left(h_b, h_a\right) = \exp\left(-\frac{\left\| h_b - h_a \right\|^2}{2\sigma^2} \right) \tag{21}$$

Environmental protection is one of the key components of sustainable growth. It comprises preserving and protecting the natural environment's land, water, air, and biodiversity. Various tactics are employed to achieve this, such as endorsing renewable energy sources, adopting eco-friendly land use practices, and implementing biodiversity conservation initiatives.

- **Planning :**

Planning is a crucial activity that entails developing strategies, defining goals, and determining the steps needed to achieve them. Finding resources, assigning them, and determining how to use them as effectively and efficiently as feasible are all included. Planning is often seen as the foundation of any successful business or project since it provides a roadmap for reaching desired outcomes.The initial step in the planning process is identifying and specifying the required goals or objectives. These objectives ought to be SMART—specific, measurable, achievable, and time-bound. They should also be consistent with the overall vision and objective of the project or organization.

The following decision function for the assessment of ecological damage in mining sites using the support vector machine can be built based on i and b.

$$p(h)=\sum_{b=1}^{M}\alpha_b \exp\left(-\frac{\|h_b-h_a\|^2}{2\sigma^2}\right)+i \tag{22}$$

The Suitability Map (ILWIS software), a raster map that uses the linear weighted combination (also known as WLC – Weighted Linear Combination) to assign a LUC suitability degree to each pixel, was created using the S-MCDA technique based on multi-attribute value theory.

Creating strategies to attain the goals is the next stage after they have been set. This entails locating and evaluating several possibilities in order to ascertain which strategy will produce the best outcomes. A few examples of strategies are product creation, budgeting, market study, and process optimization.Following the selection of a strategy, the planning process proceeds to the execution stage. Here are the comprehensive action plans that specify the precise duties and deadlines needed to accomplish the objectives. For the plan to be executed smoothly, all relevant parties must be involved, and clear coordination and communication must be maintained.

C. Operating principles

- **Environment Awareness :**

Understanding the natural systems and processes that shape our planet and the effects of human activity on them is referred to as environment awareness. It is essential to sustainable development because it empowers people and institutions to decide wisely and take actions that reduce harm to the environment. There are several degrees and dimensions to the operation of environmental awareness. Understanding the interconnection of all living things and the effects of one's own decisions and actions on the environment are key components of it on an individual basis.

$$Fb=\sum_{a=1}^{m}\left(z_a * h_{ba}\right) \tag{23}$$

The weights of energy, population growth, environmental management systems, technological innovation, and green growth were estimated for Pakistan's instance using the ADGIA model.

$$\beta 01=\frac{1+|\gamma 0|+|\gamma 1|}{1+|\gamma 0|+|\gamma 1|+|\gamma 1-\gamma 0|} \tag{24}$$

Thus, planning and policymaking can benefit from the adaption strategy. The following formula can be used to get the combined demand and supply zone.

$$BQW_j=\left\{\frac{1}{m}\sum_{0}^{q} ifc \le c\_\max\right\} \tag{25}$$

$$IDZ_a = pop * gcap \tag{26}$$

where an is the area's integrated supply zone (a in km2), d max is the greatest radius at which supply services can be provided, and an is the Euclidean distance between two regions (a).This means being aware of how resources are used, waste is produced, and other activities that could affect the environment. It also means appreciating the value of biodiversity and the importance of conservation initiatives. Creating and implementing practices and policies that lessen environmental impact and promote sustainability is what is meant by environmental consciousness at the organizational level. This could mean using less energy and water, initiating recycling programs, and utilizing renewable resources. It also means considering the ecological effects of corporate decisions and incorporating sustainable practices into daily operations. One of the most important aspects of environmental awareness is education. The operating flow diagram can be seen in the following figure, 3.

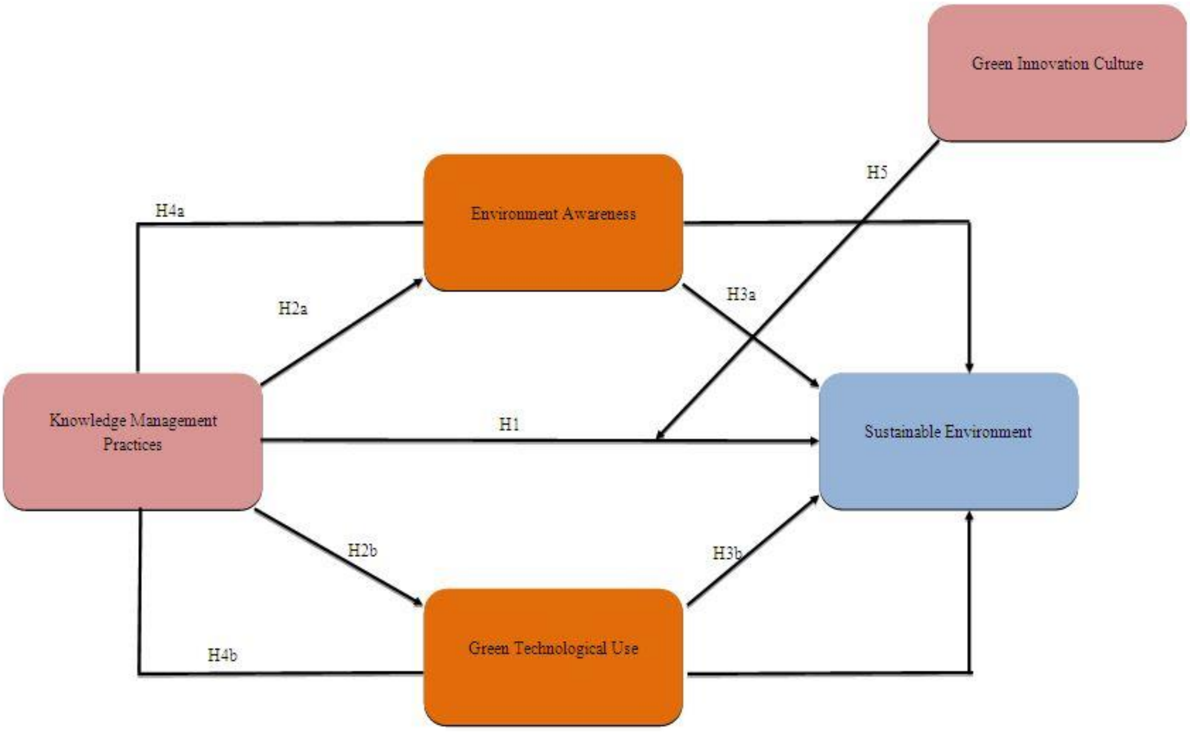

Fig 3: Operational flow diagram

This entails giving people and organizations the information, comprehension, and resources necessary to make wise decisions regarding ecological issues. Training programs, awareness campaigns, and educational institutions can all help achieve this. Planning is an essential process that includes goal-setting, strategy development, and determining the actions required to reach those objectives. It includes identifying resources, allocating those resources, and figuring out how to use those resources in the most effective and efficient way possible.

- **Knowledge Management Practices :**

Knowledge management (KM) practices involve processes and techniques to identify, capture, store, and share knowledge within an organization. These practices combine technology, people, and methods to create and leverage knowledge for the organization's benefit. Let's have a closer look at the different operations of KM practices. Knowledge Identification: The first step of knowledge management is identifying and categorizing an organization's knowledge. This involves identifying the types of knowledge (implicit or explicit) and determining the sources of knowledge within the organization.

All five land classes from the LULC maps from 2000 and 2020 were combined with the DEM and road map using the correct methodology to create the predicted 2030 and 2040 maps.

$$v+1_{Cf_{ab}} = \left(\left(\sum_j v_{pp_{ja}} \times Z_j \right) \times v_{M_{ab}} \right) \prod_m v_{d_{mab}} \tag{27}$$

We apply the Lagrange Multiplier (LM) test and the CD test, as recommended by Breusch and Pagan (1980), to address the issue. The CD test uses the following equation to determine whether CD is present in the data.

$$DC = \sqrt{\frac{2V}{M\left(M-1\right)}}\left(\sum_{b=0}^{M-1}\sum_{a=b+1}^{M}\rho_{ba}\right) \tag{28}$$

where T represents the period and N the cross-sections. It explains the uneven correlation of stochastic changes.

The following equation is used by the LM test to look at the CD in the panel data.

$$k_{bv} = \alpha_{bv} + \beta_b h_{bv} + \varepsilon_* bv \tag{29}$$

Surveys, interviews, and other data-gathering methods can be used to do this. Knowledge Capture: After knowledge has been located, it needs to be recorded in an accessible manner. Wikis, collaborative platforms, and knowledge databases are just a few of the tools that can be used for this. It is necessary to structure and arrange the collected knowledge so that it can be found and retrieved with ease. Knowledge Storage: To enable simple access and retrieval, the collected knowledge must be kept in a central repository. This repository may take the shape of a physical library or a digital information base.

- **Green Innovation Culture :**

The idea of "green innovation culture" is to promote and assist the development and uptake of novel, ecologically friendly products, services, and technologies. With the intention of promoting sustainability and minimizing environmental effect, it entails incorporating green practices and concepts into the organizational culture and daily operations. Gaining a thorough understanding of the organization's present environmental performance and pinpointing areas for improvement is the first step towards creating a Green Innovation Culture. This entails going into every aspect of the company's operations in detail, including trash disposal, energy use, and carbon emissions. After that, environmental targets can be set and a plan for accomplishing them can be established using the data from this evaluation.

Second generation unit tests have been utilized in a number of studies in the literature to look at the stationary qualities of the variables. It is characterized by the following:

$$\Delta h_{bv} = \alpha_{bv} + \beta_b h_{bv-1} + \rho_b V + \sum\nolimits_{ba=0}^{m}\theta_{bv}\Delta h_{b,v-1} + \varepsilon_{bv} \tag{30}$$

Whereas t represents the period, i indicates the cross-sections, and explains the considered variable, the model's residuals are explained.

Idiosyncratic innovations and unobservable factors—which are identical among the panel units—are how residuals in factor modeling are created. Consequently, factor models for residuals are shown below.

$$\varepsilon_{bv}\lambda_v P_v + g_{bv} \tag{31}$$

$$P_{av} = \rho_a + P_{a(v-1)} + \eta_{av} \tag{32}$$

In this case, *F* stands for common factors and *F* for a vector of factor loadings that need verification.

The error term is assumed to follow a factor model in the Cup-FM estimation. Additionally, until combination, the parameters and loadings are computed repeatedly. Therefore, we might put it this way:

$$\left(\beta_{CUP}, P_{CUP}\right) = \arg\min \frac{1}{mV^2}\sum_{b=1}^{m}\left(k_b - h_b\beta\right)N_P\left(k_b - h_b\beta\right) \tag{33}$$

Elements are implemented within the error period. As a result, F receives the preliminary estimations, and the process continues until conjunction.

After establishing the ecological goals, the organization must cultivate an innovative culture. This entails inspiring staff members to come up with innovative ideas for lowering the company's environmental effect as well as developing a sense of accountability and environmental ownership. Training, workshops, and open lines of communication that let staff members offer comments and ideas can all help achieve this. A key component of Green Innovation Culture is the adoption of innovative eco-friendly practices and technologies. This entails making investments in and putting into practice modern, sustainable, and eco-friendly procedures and technology.

- **Sustainable Environment :**

The term "sustainable environment" describes the careful management and preservation of ecological systems and natural resources for the benefit of present and future generations. It entails striking a balance between providing for the needs of society and guaranteeing the protection and wellbeing of the environment. Three primary components comprise the functioning of a sustainable environment: pollution control, waste management, and resource conservational. The goals of resource conservation are to encourage sustainable use and lessen the exploitation of natural resources. This entails minimizing the use of non-renewable resources while utilizing renewable resources in an ethical and effective manner. Promoting the use of wind and solar energy in place of fossil fuels, for instance, helps to cut down on carbon emissions and the depletion of non-renewable resources. Another essential component of a sustainable ecosystem is waste management. In order to lessen the influence on the environment, waste materials must be reduced, reused, and recycled. The ecology may be harmed by the enormous amounts of waste produced by the growing population and consumption patterns, which makes this operation crucial. In order to avoid pollution and safeguard the wellbeing of living things, proper waste management also entails disposing of hazardous waste items in an appropriate manner.

3. Result and Discussion

The performance of proposed method Sustainable Site Planning and Design (SSPD) have compared with Energy Efficiency Design Index (EEDI), Energy Performance Contracting (EPC) and Waste Reduction and Management (WRM).

3.1. Energy Efficiency:

Landscape architecture should prioritize using energy-efficient design strategies, such as incorporating renewable energy sources and low-energy consumption materials and techniques. The comparison of energy efficiency between the current and suggested models is displayed in Table 2.

Table.2: Comparison of Energy Efficiency (in %)

No. of Images	EEDI	EPC	WRM	SSPD
100	83.79	82.82	83.55	97.09
200	81.82	80.40	81.35	95.10
300	80.69	79.99	80.55	93.90
400	79.48	78.39	79.88	93.42
500	79.11	76.07	78.45	91.99

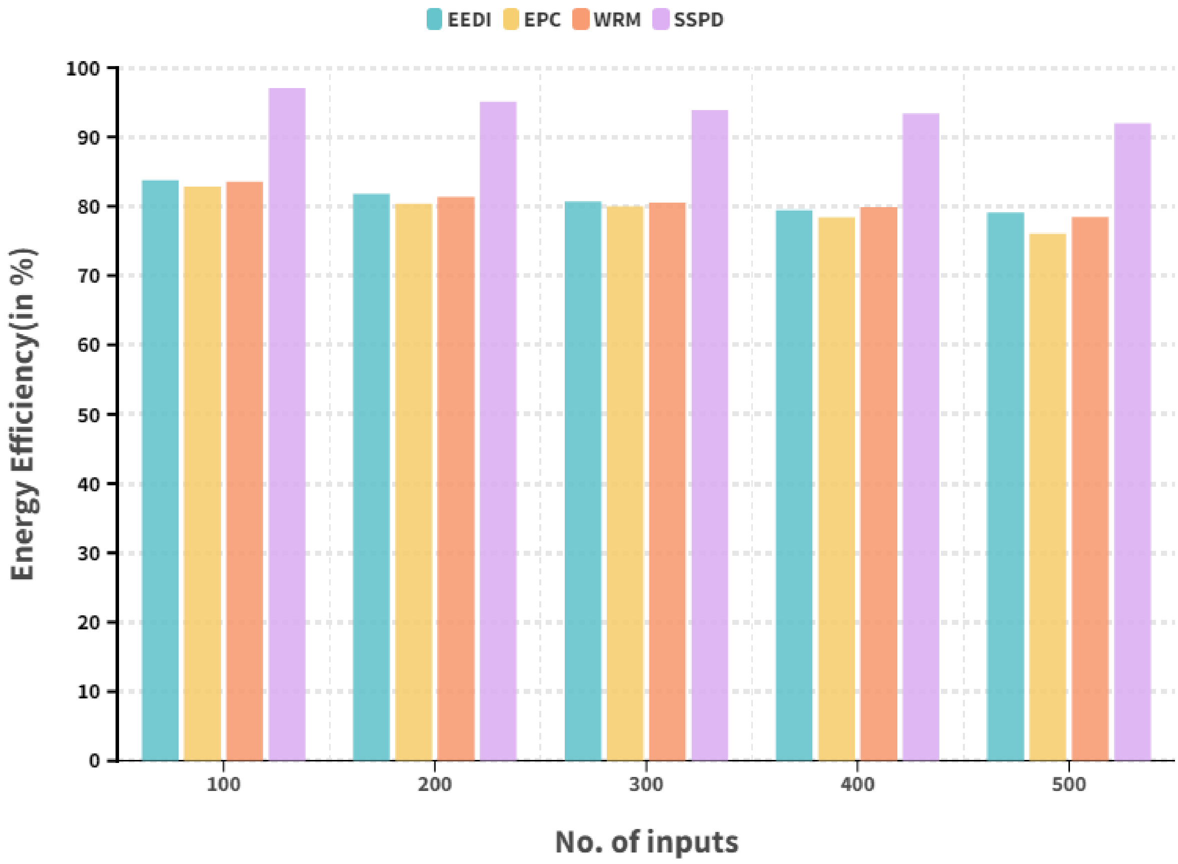

Fig.4: Comparison of Energy Efficiency

Fig. 4 shows the comparison of Energy Efficiency. In a computation cycle, the existing EEDI obtained 79.11%, EPC obtained 76.07%, WRM reached 78.45 % Energy Efficiency. The proposed SSPD obtained 91.99 % Energy Efficiency.

3.2. Water Management:

Sustainable landscape architecture focuses on preserving and efficiently using water resources through technologies such as rainwater harvesting, graywater recycling, and xeriscaping. Table.3 shows the comparison of Water Management between existing and proposed models.

Table.3: Comparison of Water Management (in %)

No. of Images	EEDI	EPC	WRM	SSPD
100	79.79	79.82	81.55	87.09
200	77.82	77.40	79.35	85.10
300	76.69	76.99	78.55	83.90
400	75.48	75.39	77.88	83.42
500	75.11	73.07	76.45	81.99

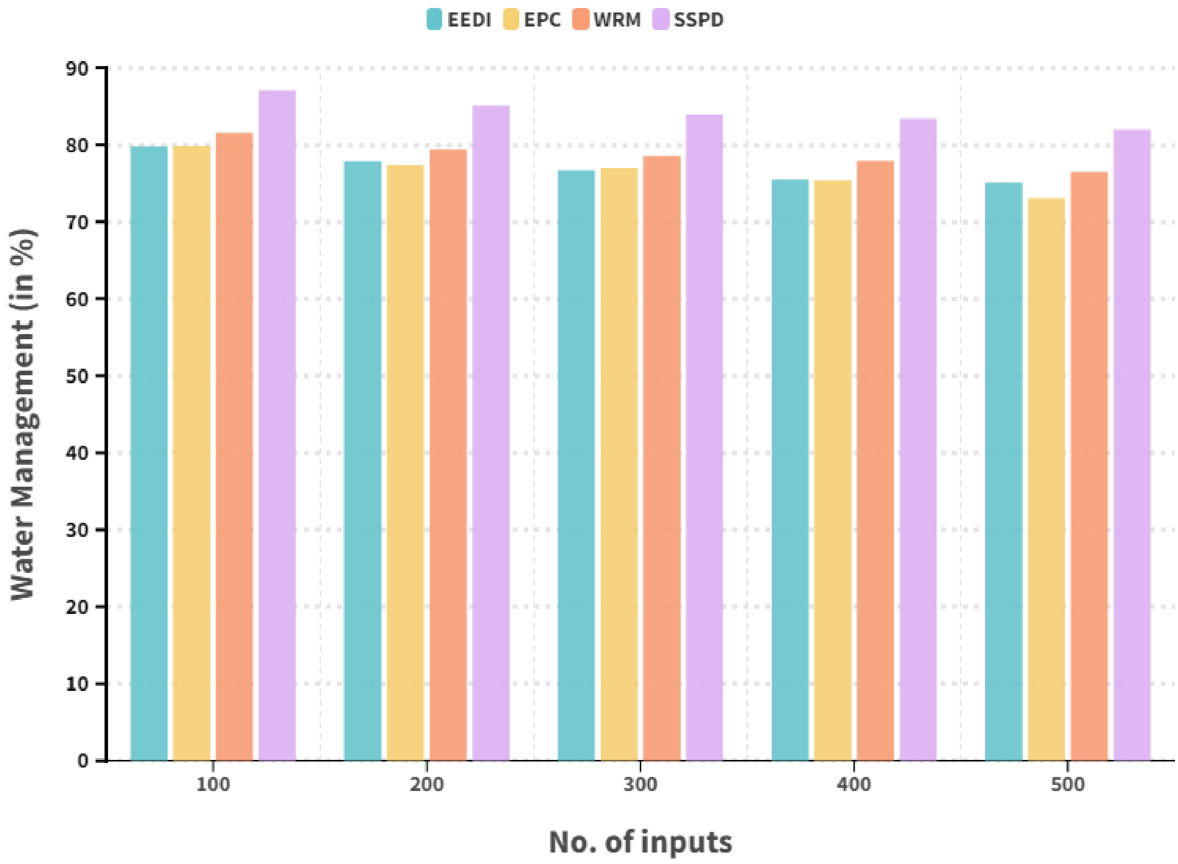

Fig.5: Comparison of Water Management

Fig. 5 shows the comparison of Water Management . In a computation cycle, the existing EEDI obtained 75.11 %, EPC obtained 73.07 %, WRM reached 76.45 % Water Management. The proposed SSPD obtained 81.99% Water Management.

3.3. Sustainable Materials:

Choosing sustainable and environmentally friendly materials for landscape development is a critical aspect of sustainable landscape architecture. It can include using recycled or locally sourced materials with a low environmental impact in production and disposal. Table.4 shows the comparison of Sustainable Materials between existing and proposed models.

Table.4: Comparison of Sustainable Materials (in %)

No. of Images	EEDI	EPC	WRM	SSPD
100	82.79	82.82	83.55	92.09
200	80.82	80.40	81.35	90.10
300	79.69	79.99	80.55	88.90
400	78.48	78.39	79.88	88.42
500	78.11	76.07	78.45	86.99

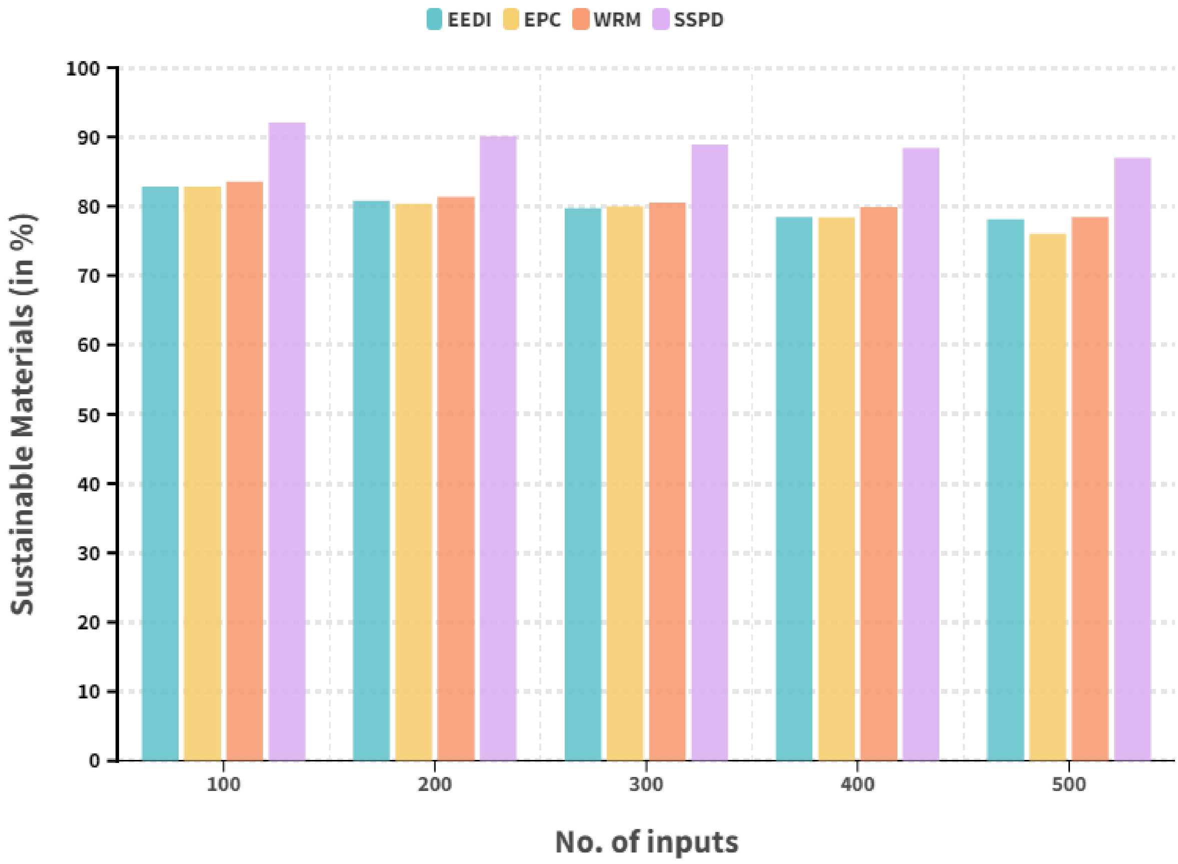

Fig.6: Comparison of Sustainable Materials

Fig. 6 shows the comparison of Sustainable Materials . In a computation cycle, the existing EEDI obtained 78.11%, EPC obtained 76.07%, WRM reached 78.45 % Sustainable Materials. The proposed SSPD obtained 86.99 % Sustainable Materials.

3.4. Biodiversity and Ecological Protection:

An essential aspect of sustainable landscape design is to promote and enhance biodiversity and protect natural habitats. It can be achieved by using native plants, green roofs, and other design elements that support and restore ecological systems. Table.5 shows the comparison of Ecological Protection between existing and proposed models.

Table.5: Comparison of Ecological Protection (in %)

No. of Images	EEDI	EPC	WRM	SSPD
100	86.79	86.82	91.55	97.09
200	84.82	84.40	89.35	95.10
300	83.69	83.99	88.55	93.90
400	82.48	82.39	87.88	93.42
500	82.11	80.07	86.45	91.99

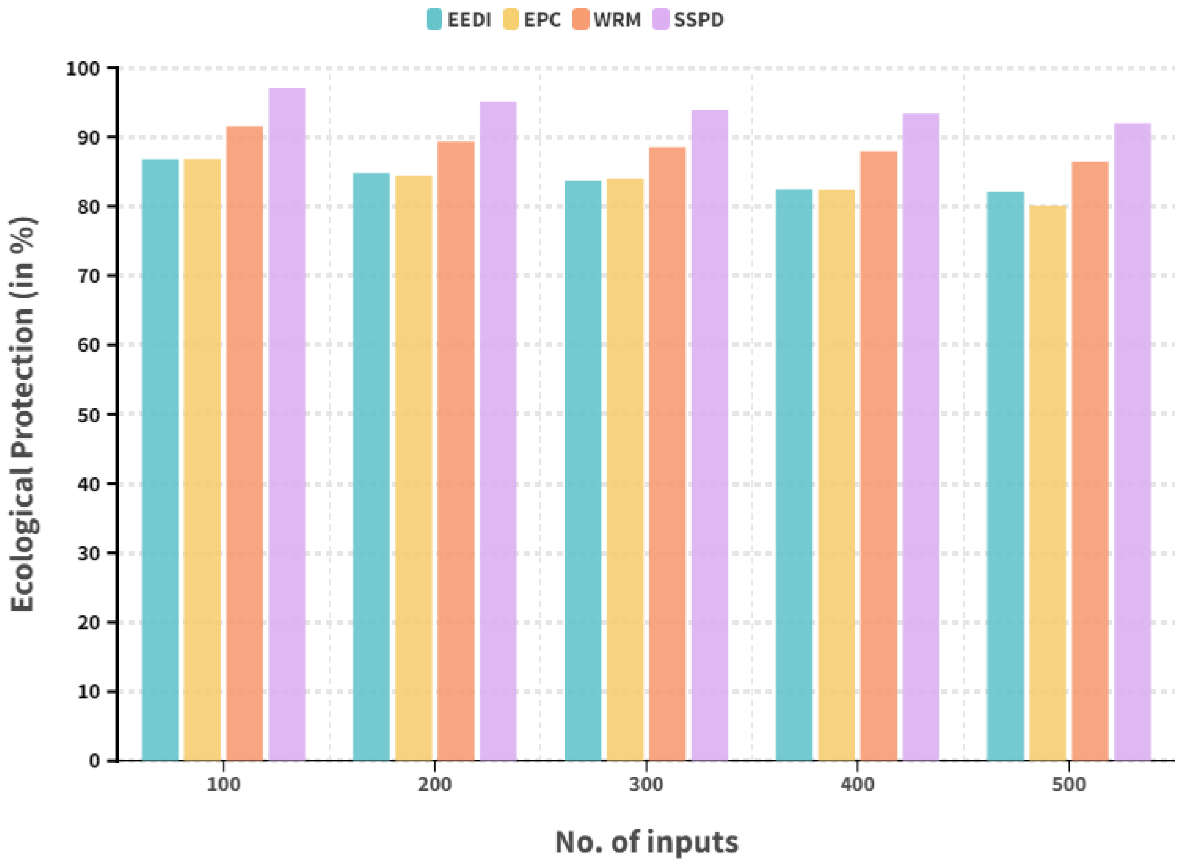

Fig.7: Comparison of Ecological Protection

Fig. 7 shows the comparison of Ecological Protection. In a computation cycle, the existing EEDI obtained 82.11%, EPC obtained 80.07%, WRM reached 86.45 % Ecological Protection. The proposed SSPD obtained 91.99 % Ecological Protection.

5. Conclusion

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