Original Research Article

Explaining the Framework for Regenerating Urban Post-Industrial Landscapes Based on a Regenerative Design and Development Approach*

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Abstract | Post-industrial landscapes with identity values are recognized as cultural heritage of the modern era. These areas have been damaged socially, economically, and environmentally, and have created an unsuitable visual landscape. Various interventions have been made in these areas, but due to the complexity of these landscapes and the damage to the ecosystem, a comprehensive approach is needed. This approach should preserve the industrial heritage values, repair past damages, and improve the mutual interaction between humans and nature. The "regenerative design and development" approach, employing a "comprehensive" and "systematic" view, uses the system's intrinsic resources to create restoration and regeneration that leads to the integration of human society's needs and nature. The research aims to provide a comprehensive framework for regenerating post-industrial landscapes with a regenerative approach. In this study, the influential factors in regenerating post-industrial landscapes in previous methods were analyzed and compared with the effective trends in the regenerative approach and were enhanced. Then, using the Perkins + Will framework, as one of the practical regenerative frameworks, a comprehensive and innovative framework for regenerating post-industrial landscapes was presented. This framework is a multi-layered diagram consisting of a core and several rings, based on which policies and strategies for the design and development of post-industrial landscapes are provided. In this framework, "place" is the core of the system, the first ring is "place assessment dimensions," the second ring is "effective trends" in regenerating post-industrial landscapes, the third ring is "sub-trends," and the fourth ring is the "ecosystem." According to the research findings, the effective trends in regenerating post-industrial landscapes include 12 trends: biodiversity, community, economy, culture, education, aesthetics, health, participation, infrastructure, materials, energy, and water. This framework can be applied to regenerate post-industrial sites ranging from a small workshop to a large industrial complex.

Keywords | Post-Industrial Landscape, Regenerative Design and Development Approach, Effective Trends, Perkins+Will Framework, Comprehensive Framework for Regenerating Post-Industrial Landscapes.

Introduction | Abandoned industrial sites represent one of the fundamental challenges within urban spaces, contributing to urban fabric disjunctions, visual pollution, and insecurity.

These areas, termed post-industrial landscapes, initially served functional economic purposes but are now unused, derelict, and neglected, commonly found in urban, rural, and suburban contexts (Farahmand, 2011). These deteriorated systems suffer from a lack

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of social and economic functionality and environmental pollution, creating visually unappealing landscapes (Loures, 2008). Post-industrial landscapes form desolate voids within urban spaces (Baharloo, 2009), reflecting the evolutionary trajectory of human life and constituting part of the modern cultural heritage, thus highlighting the importance of preserving this industrial legacy (Swensen, 2012; Loures & Burley, 2012). Regenerating these spaces generates new landscapes that reintegrate into urban life as daily living environments for citizens (Loures & Panagopoulos, 2007). Strategies aiming at the comprehensive regeneration of post-industrial landscapes can restore degraded environments, improve ecosystems, and integrate these areas into the urban fabric (Loures, 2008). The "regenerative design and development" approach fosters renewal within a system based on ecological concepts (Gibbons et al., 2018). The regenerative theory, rooted in philosophical perspectives based on "ecological" concepts, directs a broad range of ideas and approaches toward integrating the needs of society and nature (Habibi, 2021). This study examines intervention methods in post-industrial landscapes, aiming to present a comprehensive framework for their regeneration by exploring the concepts of the regenerative approach and the Perkins + Will framework as an applicable model.

Research Question and Hypothese

Various intervention methods, including structuralism, renovation, renewal, and ecological and sustainability approaches, have been employed for regenerating post-industrial areas. However, due to extensive and varied damages, including social, economic, environmental, and visual impacts, these approaches alone cannot create a comprehensive strategy for regenerating post-industrial landscapes. Thus, a holistic and integrated approach is required to address past damages and foster development. The hypothesis posits that utilizing the concept of the "regenerative design and development" approach, along with the "Perkins+ Will framework," can offer an innovative and comprehensive framework for regenerating post-industrial landscapes, providing an integrated strategy for designing and developing these areas. The following research questions arise:

1. What are the effective components of various intervention methods in post-industrial landscapes?

2. Are the effective components in post-industrial landscapes compatible with the influential currents in the regenerative approach?

3. How does Perkins +Will framework contribute to creating a comprehensive framework for the regeneration of post-industrial landscapes?

Literature Review

The research employs a historical-interpretive method, In the mid-20th century, the preservation of industrial heritage began in the United States and Europe, gaining significant attention within the context of industrial heritage (Cho & Shin, 2014). In 2012, the Taipei Declaration by the Asian Industrial Heritage Council emphasized the necessity of preserving Asia's industrial heritage as an integral part of collective memory and economic,

social, and cultural transformations (Ghanbari, 2019). Post-industrial landscapes have played a significant role in the future of urban and rural environments (Loures & Panagopoulos, 2007). Since the 21st century, artists and architects have been pivotal in preserving and designing these landscapes. Pioneers like Robert Smithson and Michael Heizer have highlighted the importance of human interaction with ecosystems (Lehenbauer, 2012). Latz has also focused on reconciling and preserving industrial lands (Radaei, 2011). Richard Haag gained prominence with his Gas Works Park project in Seattle. The theorists' perspectives and intervention methods in post-industrial areas are summarized in Table 1.

Based on global experiences, interventions in post-industrial areas have been replaced with recreational uses, transforming these areas into modern environments with "industrial memory" characteristics. Examples of successful post-industrial landscape regenerations include Zollverein Park in Germany, Duisburg Nord Park in Germany, Dora Park in Italy, André Citroën Park in France, and the Zhongshan Shipyard Park in China (Shevchenko & Novoselchuk, 2022).

International studies indicate that the regeneration of post-industrial landscapes enhances place attachment and urban identity, and can have positive economic, social, and environmental impacts (Cercleux et al., 2012; Scaffidi, 2015; Bailey, 2012; Merwin et al., 2022).

As evidenced by the literature review, existing intervention methods and approaches have not achieved comprehensive and integrated regeneration of post-industrial landscapes. Despite various intervention methods, there is a pressing need for an innovative and integrated approach to regenerate these areas, ensuring their effective integration with urban environments through comprehensive strategies.

Research Methodology

This research employs a descriptive-comparative method, utilizing library studies to review the literature including electronic articles on post-industrial landscapes and the regenerative approach as a comprehensive and systematic methodology. The "Perkins + Will framework," one of the practical frameworks of the regenerative approach, aims to create a "symbiosis of human and natural systems." Given that the goal of the Perkins + Will framework aligns to regenerate post-industrial landscapes, this study leverages it to propose a new framework. Although the Perkins +Will framework is practical and organized, applicable at scales ranging from a single building to an entire city (Cole et al., 2012) it does not offer practical methods and instead advances design and development by posing challenging questions about each "place."

In the first step, the study identifies the effective components in post-industrial landscapes through previous intervention methods. In the second step, the regenerative approach is examined as a comprehensive and systematic approach, logically aligning the "effective components" in post-industrial landscapes with the "effective currents" in the regenerative approach. Due

Table 1. Perspectives of theorists and methods of intervention in post-industrial landscapes. Source: Authors.

Theoreticians	Method of intervention	Theory
Robert Smithson	land art	Using art as a mediator between industry and the environment and creating visual beauty to preserve industrial nature as a cultural heritage (Kastner & Wallis, 1998).
Michael Heizer		Creating original art by creating symbolic abstract forms, on a large scale. This semantic view appears mostly in symbolic forms to revive post-industrial platforms (Krinke, 2001).
Herman Parrigan	Ecological art	Renewal of ecological, cultural, historical, and social beauty using art and linking it with the industrial site (Weilacher, 2004).
Agnes Denes		Creating a connection between science and art in creating a memorial work of art according to the principles of ecological, cultural, and social sustainability (Wallen, 2012).
Peter Latz	Structuralism	The definition of new ecology in the landscape is about the existing industrial structures on the site and preserving them as a cultural landscape. Latz considers the organization of a "bad place" to have a special place in his design thought (Hojjati & Shirazi, 2011).
	Upcycling	Reducing costs and protecting the environment as well as using industrial buildings and structures by defining new activities (Weilacher, 2008).
Richard Hogg	Improvement and Renovation	Creating a new and innovative landscape while preserving the industrial character of the site by preserving the remaining industrial element (Cui & Fang , 2015).
Adolphe Alphand	Palimpsest	Creating a new and innovative landscape while preserving the industrial character of the site by preserving the remaining industrial elements (Krink, 2001).
Manuel Palermo	Return connection human and nature	The return of the relationship between man and nature with the homogeneous design of the mineral and post-mineral landscape to achieve beauty preserve identity and improve environmental quality (Schir, 2010).

to the comprehensive nature of the regenerative approach, the components of post-industrial landscapes overlap with and are enhanced by the effective currents of regeneration. In the third step, the "Perkins + Will analytical framework" is employed to achieve a "comprehensive framework for the regeneration of post-industrial landscapes." By overlaying the comparative currents from the previous steps (Steps 1 and 2) and relying on the Perkins+ Will framework chart (Step 3), a new framework is devised. This innovative framework addresses the application of the regenerative approach in post-industrial landscapes, offering strategies and policies for place analysis, design, and development. The new framework and proposed strategies are generalizable to various types of post-industrial areas at different scales. The research process is depicted in Fig. 1.

Theoreical Foundation
• Post-industrial landscapes
Post-industrial landscapes, which have been damaged by social, economic, and environmental pollution, possess significant potential for regeneration and are considered part of the shared heritage and identity of society (Loures & Panagopoulos, 2007; Loures, 2012; Radaei, 2011). These landscapes can play critical roles in the future of urban and rural environments (Chen et al., 2016). Intervention approaches include socio-cultural, heritage, environmental, and sustainability perspectives (Yang & Cho, 2023). Culture, the preservation of industrial architecture, and aesthetics play key roles in the regeneration of these landscapes (Nikezic & Jankovic, 2022; Douvlou & Stachura, 2024; Han & Zhang, 2022; Rojas, 2022; Xu & Aoki, 2018).

To date, interventions have focused on not only preserving and celebrating "heritage-cultural identity" but also improving economic, social, and environmental functions, redefining aesthetics with new concepts. The effective components in post-industrial landscape interventions are compiled in Table 2.

Although various intervention methods have significantly improved and developed post-industrial sites towards re-integration into urban life, these sites cannot be fully restored to urban vitality through conventional methods due to the ecological damage they have sustained. Therefore, the recycling of these sites requires specific measures in landscape design, ecology, and urban planning, including the restoration of natural systems (air, water, soil, and habitats). The regenerative design and development approach, with its holistic perspective, extends beyond ecological and sustainability approaches, systematically fulfilling the mutual needs of humans and ecosystems.

• Regenerative design and development approach
The regenerative design and development approach integrates ecological concepts and sustainability goals and methods, considering design as an integral and systemic element to improve the quality of life, the environment, and the economy (Mang & Haggard, 2016; DuPlessis, 2012). This approach provides a framework for the adaptation and integration of modern and traditional technologies in designing sustainable environments and enhancing the health and vitality of communities (Habibi, 2021). Its integrated infrastructure has the potential to accelerate the transition towards regenerative sustainability (Gibbons et al., 2018). In 1997, Larrick analyzed
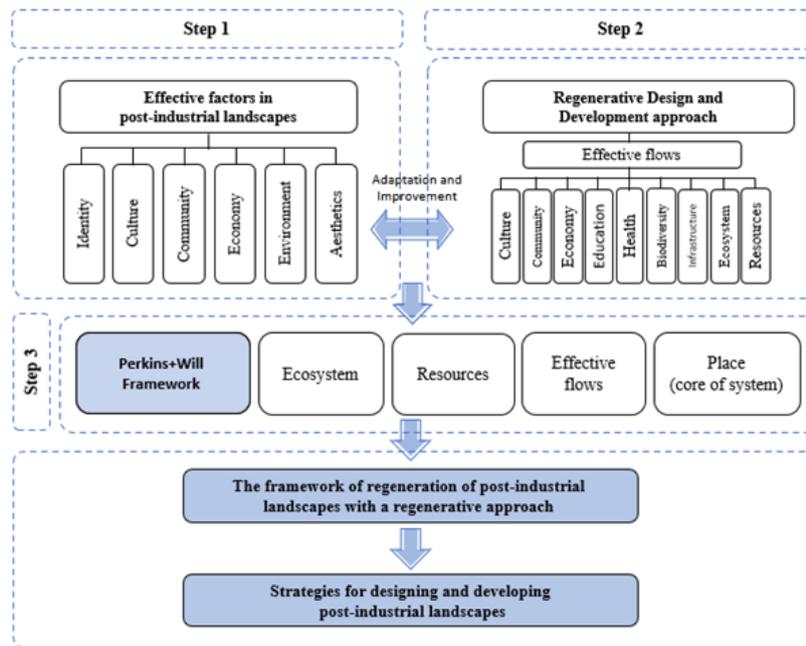
Fig. 1. Research process. Source: Authors.

non-regenerative and regenerative processes, introducing sustainable design as a neutral phase (McDonough & Braungart, 2002; Jenkin & Zari, 2009; Cole, 2012). Larrick's 1997 descriptive chart of non-regenerative and regenerative processes (Fig. 2) was a significant milestone.

In 1994, Lyle introduced the term "regenerative" in urban landscape design, stating that designers could restore lost ecosystems. Landscape design, including post-industrial landscapes, often relies on dominion over nature (DuPlessis & Brandon, 2015). This approach views the site as a network of dynamic and influential flows (Haggard, 2002). Regenerative design, beyond conservation and restoration, focuses on the continuous evolution of culture within the context of life's progression (Mang & Reed, 2020). Key flows include environment, culture, community, infrastructure, and energy (Kashkooli et al., 2018).

Thus, in the regenerative approach, the site is examined from multiple dimensions: geographical location and scale, damage assessment, potential and opportunity identification, and dialogue with residents and stakeholders (Fig. 3).

In recent years, various analytical and executive frameworks have

Table 2. Effective Factors in Regeneration of Post-industrial Landscapes. Source: Authors.

| Effective Factors	Dimensions of Factors
Identity (Han & Zhang, 2022; Beeston, 2020)	-Industrial heritage as the main identity of the site. -Indicator elements as a symbol and sign of the identity of the department. -Sense of place and social memories.
Culture (Erlewein, 2017)	-Emphasis on industrial elements as cultural signs. -Combining the vernacular culture of the region with the post-industrial landscape. -Preserving vernacular worthiness and beliefs.
Community (Song et al., 2024)	-Opportunities to strengthen social interactions. -Improving public security in the region. -Creating vigor and vitality.
Economy (Dell'Anna, 2022)	-Creating employment and creating new businesses. -Creation of local jobs.
Environment (Merwin et al., 2022)	-Cleaning soil and water pollution. -Preservation and strengthening of native species of the region. -Creating biodiversity.
Aesthetics (Rojas, 2022)	-Defining visual beauty by creating harmony between industry and nature. -Creating conceptual beauty. -Definition of functional beauty.
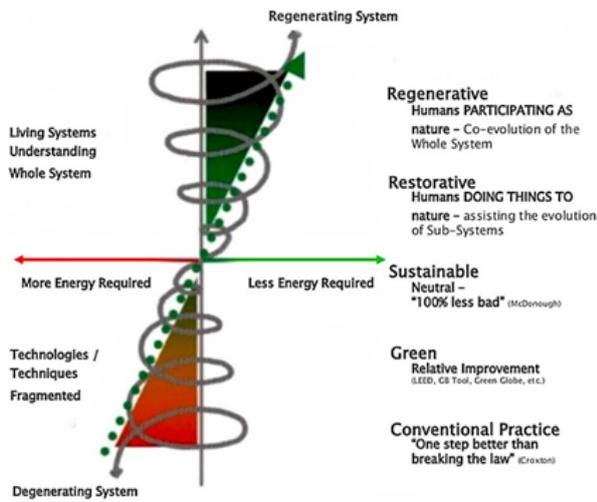
Fig. 2. Design a trajectory diagram from a green model to sustainability to a regenerative. Source: Mang & Reed, 2012.

been proposed by universities and research institutions to simplify regenerative thinking and apply this approach to projects. Among the most notable frameworks are ReGEN, EcoBalance, LENSES, and Perkins+Will (Middleton et al., 2020).

Perkins+Will framework

This practical framework in the regenerative approach aims to encompass strategies beyond "green design," enhancing the participation of users, stakeholders, and professionals (Cole, 2012). Its objectives align with the regeneration of post-industrial landscapes, seeking the positive coexistence of human and natural systems. The framework is used to manage various system components such as "health," "education," and "engagement," applicable from a single building unit to an entire city. Hence,

this article utilizes this framework to propose a new framework for post-industrial landscapes. The Perkins Will framework comprises two main sections: the "problem-oriented" section, focusing on the site, human needs, and resource flows, and the "process-oriented" section, which raises challenging questions (Cole et al., 2012). The influential flows within the Perkins Will framework are summarized in Table 3.

The Perkins Will framework places "place" at the core of the system. In the first ring, the influential flows are based on human needs, and in the second ring, the ecosystem is considered. This diagram illustrates the mutual influence of all flows on each other and the ecosystem. This research aims to utilize the Perkins Will framework for the regeneration of post-industrial landscapes. Key influential flows include enhancing individual health, social and cultural vitality, and strengthening a healthy economy. These flows are of special importance in the regeneration of post-industrial landscapes and need to be addressed in various dimensions to be effective in policy-making design.

Discussion

Reviewing the literature on post-industrial landscapes reveals that intervention methods in these areas have considered six factors for re-integrating these areas into urban life: "identity," "culture," "community," "economy," "environment," and "aesthetics." The regenerative design and development approach proposes influential flows such as health, participation, ecosystem, education, and resources, which can address broader dimensions of post-industrial landscapes. In this approach, the "place" is recognized as the unique source of the system, forming a socio-ecological whole resulting from complex interactions within the ecosystem. Each place possesses unique patterns of identity, culture, ecology, and economy. By matching the effective components in the post-

Fig. 3. Investigation Factors of Place. Source: Authors.

Table 3. Effective flows in the framework of Perkins+Will. Source: authors taken from Cole et al., 2012.

Flows (Factors) of human demands	Flows (Factors) of resources	Ecosystem
- Increasing personal health and well-being - Increasing social vitality - Increasing cultural vitality - Strengthening a healthy economy	- Production cycles - Use - Recycle - save * (Resources: water, energy, land, materials, and materials)	-Strengthening the sense of place and connection with nature -Enjoying clean air -Improving habitat and biodiversity

industrial landscape (Table 2) with the influential regenerative flows, we can not only address the overlaps but also fill the gaps in previous intervention methods, enhancing the design and development process.

Besides the components of post-industrial landscapes that align with the flows of "culture," "community," "economy," "environment," and "aesthetics" in the regenerative approach, flows such as "health," "education," "participation," "infrastructure," and "resources" are also crucial for the regeneration of post-industrial landscapes. These flows were not addressed in previous intervention methods. Flows like "food" and "housing" have less direct relevance to post-industrial landscapes and are thus excluded. Resources include "water," "materials," and "energy,"

which are critical challenges in post-industrial landscapes and are therefore considered independent influential flows. The adaptation shown in Table 4 presents 12 influential flows for the regeneration of post-industrial landscapes. Each flow comprises sub-flows detailed in Table 5.

Considering the regenerative approach concepts and the Perkins Will framework emphasizing the importance of place, the new framework places "place" as the main system role, analyzed based on geographical location, damages, potentials, and stakeholder dialogue. The influential flows for the regeneration of post-industrial landscapes match the components of the post-industrial landscape with the regenerative approach (Table 4). The innovative framework consists of a core and several rings (Fig. 4), with more

Table 4. Examining and matching the effective factors in post-industrial landscapes and the regenerative design and development approach. Source: Authors.

Effective Factors inPost-industrial Landscapes	Effective Flows (Factors) in the Regenerative Approach	Effective Flows (Factors) in the Regenerative Post-industrial Landscapes
- Identity - Culture - community - Economy - Environment - Aesthetics	- Community - Culture - Economy - Resources (water, energy, materials) - Ecosystem - Health - Participation - Education - Biodiversity - Infrastructure - Food - Housing	- Biodiversity - Community - Economy - Culture - Education - Aesthetics - Health - Participation - Infrastructure - material - Water - Energy

Table 5. Effective flows in the regeneration of post-industrial landscapes with the regenerative approach. Source: Authors, 2023.

Row	Effective Flows	Sub Flows
1	Biodiversity	Diversity of native vegetation/animal species and creation of habitat/soil
2	Community	Social interactions/social justice/social security/vigor and vitality
3	Economy	Job creation/creating local jobs/profitability of natural and human systems
4	Culture	The industrial identity of the place / industrial index elements/signs of cultural heritage/values and beliefs of the region
5	Education	Teaching revival thinking / teaching the necessary skills for the project's goals
6	Aesthetics	Visual beauty / semantic beauty / functional beauty
7	Health	Health of natural systems (water, soil, air, vegetation, and animal species) / physical and mental health of humans / healthy relationship between humans and nature
8	Participation	Participation of experts, relevant public and private bodies, residents and users
9	Infrastructure	Land use/reuse of facilities/transportation
10	Material	Recycling of materials and materials/use of materials appropriate to the use of the site/use of local materials
11	Energy	Clean energy production/energy optimization/consumption management
12	Water	Water resource management/water recycling and storage/flood control/ consumption management

extensive influential flows than the Perkins Will framework (Table 3). Comprehensive strategies for the design team to policy-make post-industrial landscapes are provided (Table 6). This framework leads to human and environmental coexistence, adding value at the site and urban fabric scale. It is practical, organized, and can be generalized for various post-industrial areas of different scales.

Conclusion

Post-industrial landscapes, resulting from human intervention in the environment during the industrial era, are valuable records of past life and human progress over a period of time. They are recognized as the cultural heritage of the modern era. On the other hand, the damage these areas have inflicted on ecosystems and urban life necessitates a comprehensive and integrated approach. An approach that preserves the values of industrial heritage while repairing past damages to improve the mutual relationships between human and natural systems.

In the first step of this research, six factors were identified as effective components in post-industrial landscapes based on previous intervention methods: "identity," "culture," "community," "economy," "environment," and "aesthetics." In the second step, the regenerative design and development approach and its influential flows were examined as a comprehensive approach for integrating and coexisting human and natural systems to regenerate post-industrial landscapes. The effective components in the regeneration of post-industrial landscapes in previous methods

were then matched with the influential flows in the regenerative approach and enhanced according to Table 4.

In the third step, the Perkins Will framework, one of the practical frameworks of the regenerative approach, was reviewed, and the components of the post-industrial landscape were matched with it to develop an innovative and comprehensive framework for the regeneration of post-industrial landscapes. This framework, depicted as a multi-layered diagram, includes a core and several rings, providing policy-making guidelines for the design and development of post-industrial landscapes (Fig. 4).

In this framework, "place" is the system's core, with the first ring, the "dimensions of place analysis," the second ring, the "influential flows" in the regeneration of post-industrial landscapes, the third ring, the "sub-flows," and the fourth ring, the "ecosystem." The influential flows in the ecosystem are defined and presented as 12 effective flows, including biodiversity, community, economy, culture, education, aesthetics, health, participation, infrastructure, materials, water, and energy. Among these, the ecosystem serves as the final ring, providing a basis for the mutual influence of flows. Table 6 offers strategies corresponding to each flow, guiding the design team. The findings of this research provide a suitable basis for future studies based on this framework for the regeneration of post-industrial sites.

Declaration of No Conflict of Interest

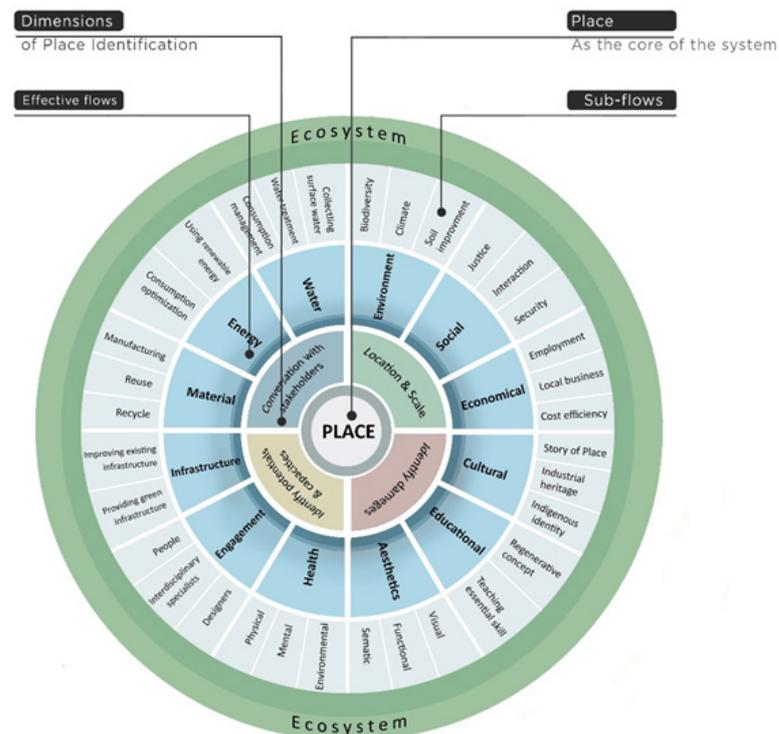The authors declare that they have no conflict of interest in conducting this research.

Fig. 4. The framework of regeneration of post-industrial landscapes with a regenerative approach. Source: Authors.

Table 6. Strategies for regeneration of post-industrial landscapes with a regenerative approach. Source: Authors.

Effective Flows	Design and Development Strategies
Biodiversity	- Preserving primary vegetation and planting native vegetation - Combining diverse vegetation with remaining industrial infrastructure - Restoring soil damage and preventing further soil erosion - Creating habitat for native life, animals, and plants
Community	- Converting old industrial equipment into spaces for cultural, social and recreational activities - Hosting various events in redesigned industrial halls - Holding social gatherings in open spaces (an opportunity to create social interactions)
Economy	- Creating an economic cycle by transforming industrial sites into recreational and cultural spaces and generating added value - Creating new jobs and attracting investors - Creating spaces for co-working spaces
Culture	- Connecting with local culture and transforming it into a place capable of hosting cultural gatherings - Revival of industrial identity as cultural heritage
Education	-Teaching revitalization thinking and teaching the necessary skills for the project's goals - Providing an environment for cultural, ecological and technological training
Aesthetics	- New aesthetic definition with respect to industrial heritage - Spatial diversity and creating visual quality at different levels - Engaging the audience's senses in understanding beauty
Health	- Improving the ecological quality of the environment by planting plants that help clean the environment - Improving human physical and mental health by creating sports spaces and relaxing spaces
Participation	- Participation of various experts in the field of architecture, landscape architecture, biology and urban planners - People's participation in the design process through communication between experts and people
Infrastructure	- Creating integration with the urban fabric through a network of pedestrian, bicycle and cycling paths - Reusing existing industrial facilities and infrastructure with new uses - Creating new uses appropriate to the needs of the region
Materials	- Recycling and reuse of materials on site - Using materials suitable for site use - Using native and recyclable materials
Energy	- Use of clean energies such as solar energy - Use of renewable energies - Smart energy use for optimal consumption
Water	- Water consumption management with the help of technology - Water recycling, storage and reuse and efficient methods for surface water disposal (e.g. rain gardens) - Water purification for non-potable uses, including plant irrigation, to conserve water resources and save significant costs

Endnotes

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