



Reviving Historic Cores: Meeting Sustainability Goals Through Urban Recycling

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Abstract. Historic cores are essential city areas that preserve cultural heritage, urban fabric, and architectural identity. Despite their cultural and architectural significance, historic cores face challenges in adapting to modern urban needs and there is a lack in achieving a comprehensive process that helps in reviving them. Urban recycling has emerged as a transformative solution, revitalizing and repurposing underutilized or deteriorating spaces while preserving their historical essence. While the concept of sustainability, which seeks to meet current needs without compromising future generations, is at the heart of urban recycling. By balancing environmental protection, social equity, and economic growth. This paper introduces sustainable urban recycling as a holistic approach to address the environmental, cultural, social, and economic goals within historic cores. It emphasizes how this process can safeguard heritage while meeting diverse urban needs, improving residents' quality of life, and ensuring long-term urban sustainability. By exploring the goals of each aspect, the study highlights the potential of sustainable urban recycling to transform historic cores into thriving, inclusive, and resilient urban spaces for current and future generations. Since the sustainable urban recycling goals have not been evaluated before in different historical cores, a comprehensive analysis of two different case studies has been implemented in Bologna, Italy, and Historic Cairo, Egypt to identify the importance of the goals and how they are interdependent and must be achieved simultaneously to achieve a successful historic core for the current community and for the future generations.

Keywords: Environmental Goals, Social Goals, Cultural Goals, Economic Goals.

1 Introduction

Historic cores are the most essential areas of the city, as they contain the history of different eras and the cultures of the people who lived there. This unique area is considered as the physical whole of the

city, they reflect the urban fabric and the identity of the structures and architectural heritage. Historic cores are typically distinguished by narrow streets and a dense urban layout, as well as large heritage buildings, and they possess a much smaller human scale, encouraging walking and public places where the community may connect [1]. While they are culturally and architecturally valuable, they experience several challenges in meeting current urban needs [2] In order to meet these current needs and the future generation's needs a sustainable urban recycling process has taken place in many historic cores. Urban recycling involves revitalizing and repurposing existing urban areas, particularly those that have fallen into disuse or disrepair. It is a process of the physical, spiritual, social, and cultural transformation of urban areas, buildings, or whole old towns in order to preserve the memory of cities and raise the level of their urban culture, and it is one of the axes of sustainability, the recycling process is constant, and not final till the objects and places exist. It can be started again at any time. If towns are treated as living organisms, with constant economic, social, and environmental changes, this process can provide their vitality [3]. While Sustainability refers to the practice of meeting current needs without compromising the ability of future generations to meet their own needs. It encompasses environmental protection, social equity, and economic development, aiming for a balanced and enduring approach to progress [4].

This paper aims to introduce sustainable urban recycling process as a holistic approach in historic cores (see Fig. 1), which helps in the development of the environmental, cultural, social, and economic aspects that preserve the heritage of a city and the achievement of people's different needs and social well-being, and discuss the various goals of each aspect. The thesis involves a comprehensive analysis of two types of samples, International and Egyptian including Bologna, Italy's historic core, and Historic Cairo, Egypt's historic core, it presents a detailed examination of their architectural characteristics, historical significance, current conditions, and sustainability measures. Bologna Historic Core shows great success in social, cultural, and economic goals which helps in enhancing community well-being and preserving the architectural heritage, however, the environmental goals need more effort to achieve sustainability of historic cores. While Historic Cairo shows improvement in environmental goals which also need more effort to remain sustained for future generations, a huge success is achieved in economic and cultural goals that help in economic growth and return for residents, however, more effort in social goals is needed to enhance the community cohesion and wellbeing. Through this analysis which is based on data collection and using the pointing system, the paper helps to identify effective strategies, tools, criteria, and solutions for achieving sustainable urban recycling goals that can be applied to other historic cores.

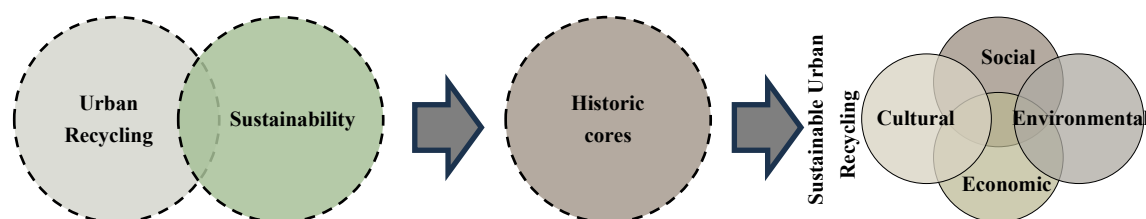


Fig. 1. Paper Structure, by the researcher.

2 Research Methodology

The paper used case study-based qualitative inductive methodology (see Fig. 2), the theoretical framework explains the concepts and goals of urban recycling and sustainability, and the relationship between them in historic cores regarding the four aspects, environmental, cultural, social, and economic

aspects. A detailed description of the sustainable urban recycling goals is proposed highlighting the importance of each goal.

A detailed analysis of the selected historic cores of Bologna Italy and Historic Cairo Egypt is applied based on the theoretical framework to determine the achievements of environmental, cultural, social, and economic goals and by using a pointing system to determine to which extent the goals are achieved and the importance of each goal. Followed by a discussion of the results of a successful historical core.

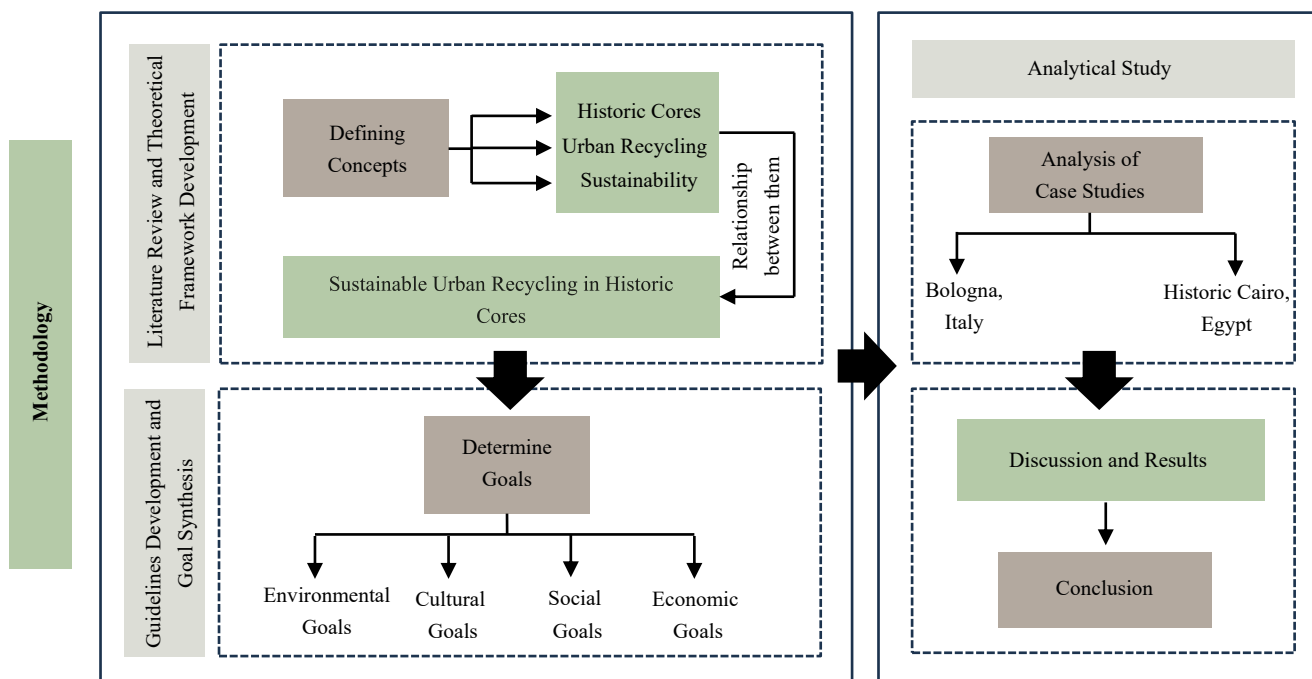


Fig. 2. Research Methodology, by the researcher.

3 Literature Review

Historic Core is the original part of a city or town that has preserved the urban fabric and physical structures from earlier eras. This usually includes buildings, streets, public spaces, and other historical, cultural, or architectural landmarks. Historic cores are typically the ones that provide the city's foundational identity, and their architectural progress, urban planning across time, and societal development have all played important roles in this. The areas are typically preserved or conserved through protection or conservation legislation, which ensures that the legacy is not significantly altered [1]. The concept of historic cores revolves around the idea of preserving the physical and cultural heritage of a city. It is recognized as the major focus of governmental, commercial, tourism, and artistic organizations. Historic cores of cities reflect the historical characteristics of cities, physical elements, and urban patterns. This unique space is considered as the physical whole of the city and contains urban elements such as markets, office centers, residential buildings, and other elements with the identity of ancient cities. The architectural urban identity of any city is born and evolves in its historic core, and recognition of this identity is only possible in this area of the city [5].

Urban recycling is a new specific urban action. It incorporates all of the experience gained in urban revitalization policy. The transition period is the time to synthesize and promote the new renewal method. One of the goals of urban recycling is to involve a wide range of specialists, municipal and private investors, and social groups, in programs aimed at saving, activating, and prospering town resources [3]. Some definitions of urban recycling have long been part of effective urban planning

practice. Even before the widely understood sustainable development theory, the concepts of moderate cities created from human needs and context-oriented architecture were followed. The terms used are very common: revitalization, protection, and transformation, and they were only a part of the process. A simple but compelling argument in favor of "recycling" is that it is always more profitable than demolition and new construction [6]. The concept of urban recycling is defined as a process of environmental, economic, social, and cultural transformation of urban areas, buildings, or whole old towns in order to preserve the memory of the cities and improve the level of their urban culture, (see Fig. 3).

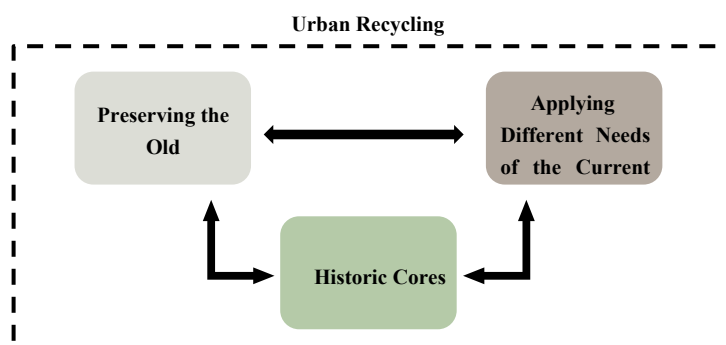


Fig. 3. Urban Recycling and Historic Cores, by researcher.

Sustainability is a complex and all-encompassing topic that is crucial for the survival of both humans and all living creatures on Earth. It represents humans' main goal in obtaining a better life and serves as a foundation for all their pursuits. Sustainability, in its most broad definition, refers to the capacity of a society, ecosystem, or other ongoing system to continue functioning over an extended time without being forced into a decline due to an absence or excessive burden of its essential resources [7]. The concept of sustainability without doubt is a wide-ranging term, and it has been growing and evolving. It was viewed through the lens of the four pillars (see Fig. 4), which are social-economic equality, community livability, and environmental protection, in 2019 UNESCO released the thematic indicators for culture heritage which deals with the complexity of culture as a fourth pillar of sustainability [8]. These pillars were integrated into project and policy decision-making [4].

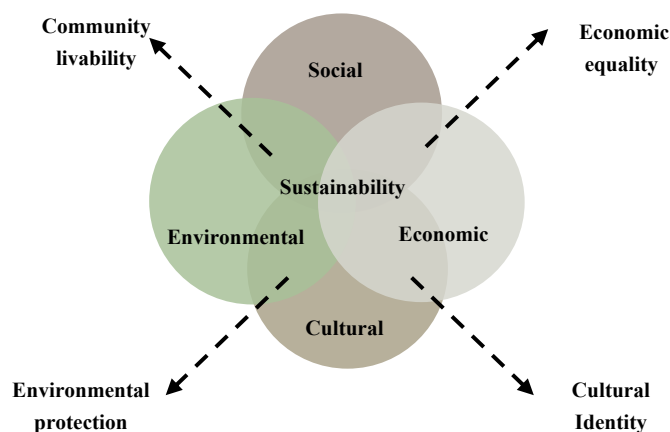


Fig. 4. Concept of Sustainability, by the researcher.

3.1 Sustainable Urban Recycling in Historic Cores

Urban recycling instead of planning and development of new urbanism is an aspect of the management and planning of existing urban areas. Successful experiences in recycling the historic cores of cities

confirm the correlation between the improvement of environmental, social, and economic conditions and preserving urban cultural heritage in these areas. According to all these, historic cores of cities are among the valuable urban areas that have various potentials, which alone play a significant role in recycling cities [5]. Urban recycling can be an effective tool for promoting sustainability and macro-level strengthening of quality of life if the principles of encouraging participation, building social character, promoting justice, promoting the environment, vitalization, and fostering economic growth can be seen following it.

Aspects of Sustainable Urban Recycling Process. Sustainable urban recycling is a comprehensive development process in social, economic, environmental, physical, and cultural areas in order to improve the quality of life in target areas and neighborhoods concerning the whole city. Sustainable urban recycling plays an important role as a community-based process for people achieving economic and social well-being through the revitalization of urban texture. The purpose of sustainable urban recycling in historic cores can be examined from the following aspects [5] (see Fig. 5):

- 1. Environmental Aspect:** The environmental aspect focuses on solving the difficulties of dense cities, such as urban recycling as a tool to revive the existing urban structures, while making better use of the existing physical structure and overcoming challenges [9].
- 2. Cultural Aspect:** It is critical to emphasize that the importance of culture in urban recycling extends beyond ethnicity, traditions, and social conventions, which are frequently used to describe the social and human dimensions. In a broader sense, cultural heritage is the result of human processes and activities in urban spaces and is not a purely physical product [9].
- 3. Social Aspect:** The social aspect seeks to create an environment that allows for the return or retention of old residents and tradespeople, fosters a sense of security and quality in these areas and allows for a diverse presence of people and tourists [9].
- 4. Economic Aspect:** The economic aspect, intends to create jobs and a vibrant retail sector, the establishment of local markets and retail areas in historic cores of cities and other elements that represent the region's native culture which attract various groups of people, from locals to domestic and foreign tourists [9].



Fig. 5. Sustainable Urban Recycling in Historic Cores, by the researcher.

3.2 Environmental, Cultural, Social and Economic Goals

The Environmental goals are critical for sustainable urban recycling in historic cores since the requirements for preservation and ecological responsibility are met. It emphasizes environmental sustainability and shows that urban recycling activities encourage lower environmental degradation and

more effective resource use. Sustainable urban recycling should therefore reduce its environmental impacts in historic cores. It creates a more environmentally friendly and resilient urban ecosystem, allowing historic cores to adapt to new challenges while preserving their environmental integrity for future generations [5]. The following are the most important environmental goals for historic cores:

- 1. Resource Conservation and Source Efficiency:** Resource conservation and efficiency play a crucial role in the sustainability of urban recycling within historic cores since it involves reduced resource consumption while retaining cultural and architectural values. Adaptive reuse strategies such as minor alterations in the reuse of historic buildings save materials and embodied energy, which are very much pertinent to sustainability. Conservation practices prioritize local materials, low-impact environmental materials, and age-old long-lasting construction practices [10].
- 2. Minimizing Construction and Demolition Waste:** Construction generates a large amount of waste therefore decreasing construction and demolition waste (CDW) is very crucial for sustainability, especially in historic preservation [11]. CDW management strategies include deconstruction rather than demolition for preservation of construction materials [12]; development of waste management plans for effective waste sorting and recycling [13]; and regulatory/incentives frameworks encouraging such practices [12]. All of these comply with global sustainability goals and the urban sustainable recycling process. It assures that rehabilitation at sites has cultural riches intact while minimizing its environmental impact.
- 3. Reducing Carbon Footprint:** Reducing greenhouse gas emissions through enhanced energy efficiency, low-carbon technologies, and sustainable urban design is possible even in historic cores. These include practices such as sustainable transportation and integration of green infrastructure, such as green roofs and permeable pavements, which help to shrink the carbon footprint along with the preservation of cultural and architectural heritage. These strategies contribute to improved air quality and livability, and ensure the resilience of historic areas for future generations [14].
- 4. Improving Infrastructure:** Improving infrastructures in historic cores is critical for their functionality, sustainability, and historic value preservation. Improvements in utility networks, environmentally friendly solutions such as energy-efficient lighting and water management [15]. Transportation improvements, such as environmentally friendly public transport and pedestrian walkways, can enhance accessibility while minimizing pollution [16]. Revitalizing public plazas and green spaces creates vibrant, welcoming areas that connect communities while preserving the culture inherited in the historic neighborhoods [15].
- 5. Promoting Circular Economy Practices:** Circular economy strategies focus on reducing resource extraction and waste generation, fostering sustainability and human well-being. Particularly relevant to the construction sector and cultural heritage buildings, these strategies preserve historical identity while promoting economic and social development [17]. By adopting principles like Reduce, Reuse, Recycle, and newer additions such as Refurbish, Repurpose, Refuse, Redesign, Remanufacture, and Recovery, the circular economy enhances resource efficiency, reduces environmental impact, and supports sustainable growth through regeneration and extended material lifespans [18].
- 6. Integrating Energy Efficiency into Historic Buildings:** Redeveloping historic buildings combines cultural preservation with technical innovation, enabling the maintenance of their unique architectural and historical significance while fulfilling their modern energy efficiency needed [19]. Energy-efficient retrofit techniques such as internal insulation, renewable energy, and advanced HVAC systems strengthen sustainability while meeting conservation principles [20]. like the Venice Charter. The European Standard EN 16883 contains specific instructions regarding energy performance improvements while taking a case-by-case, interdisciplinary approach to complement heritage conservation with sustainability goals [19].

The Cultural goals of sustainable urban recycling in historic cores focus on preserving heritage while maintaining its relevance in modern society. These areas reflect collective identity through their architecture, art, and traditions, embodying generations of cultural narratives. Sustainable practices aim to protect tangible features like buildings while revitalizing cultural practices that strengthen community engagement [5]. The following are the most significant cultural goals within historic cores:

- 1. Preserving Architectural Heritage:** It involves safeguarding, maintaining, and restoring historic structures to ensure their longevity and protect their cultural significance for future generations. This includes efforts such as cleaning, repairing, restoring, and analyzing the historical context, as well as supporting intangible cultural traditions tied to the heritage [21]. Key preservation policies include revival for contemporary use, reuse, and adaptation to modern needs, protection of cultural context from urban development, and education to promote awareness and preservation techniques [22].
- 2. Digital Tools for Heritage Conservation:** Architectural heritage is highly exposure to disasters, making its protection a critical priority, with digital technologies emerging as essential tools for monitoring, managing, and safeguarding these cultural values [23]. "Digital preservation," defined by UNESCO and WIPO, employs methods like 3D scanning, modeling, and virtual reality to document, analyze, and maintain authenticity while enhancing accessibility and conservation efficiency. Through a lifecycle conservation approach, digital technologies offer solutions across all disaster phases—pre-disaster, mid-disaster, and post-disaster—ensuring long-term preservation and societal appreciation of architectural heritage [21].
- 3. Maintaining Urban Identity and Continuity:** Urban identity connects the historical heritage of a city to the present. It manifests architecture, materials, and spatial configurations [24]. Preserving this identity in historic cores is essential for maintaining a sense of place and fostering community engagement while adapting to modern needs. This process integrates new developments within the historical context; and emphasizes local participation and continuity of cultural and social constructs [25].
- 4. The Role of Cultural Tourism:** Cultural tourism, not only revitalizes old buildings and public spaces but also contributes to shaping the identity of the community as well as economic growth. Cultural heritage tourism relies on the maintenance of all the values that attract tourists in order to manage their impacts and guarantee the authenticity and quality of the tourists' experiences. success strategies include collaboration among different stakeholders, a balance between the needs of the residents and those of the visitors, an emphasis on experiences that are genuine, and the protection of cultural and historical legacies for future sustainability [26].

The Social goals of sustainable urban recycling in historic cores are inherently linked to the preservation and adaptation of cultural and community essence to current social requirements. These historic areas have managed to remain accessible to the public and also encourage community participation and, as a result, support a stronger local identity. These interventions ensure the success of projects aimed at changing public spaces, sidewalks, and community hubs into places suitable for social interaction and traditional preservation [5]. The following are the most important social goals for historic cores:

- 1. Enhancing Community Cohesion and Cultural Identity:** Community integration for sustainable urban recycling within historic cores aims at integrating different groups into a common purpose while keeping their ethnic identity intact. This is done through common vision and mutual respect as well as opportunities for all, thereby improving social stability and relationships. Revitalizing public spaces in these areas at the same time preserves cultural heritage, encourages social relationship strength, and will help foster a sense of belonging for generations to come [27].

2. **Livable Public Spaces:** Creating livable public spaces is essential for improving living in historic cores, allowing people to live together and share cultures, as well as for recreation and community involvement. Parks and plazas make cities more livable by providing safety and access while also making the city more environmentally sustainable and reducing population gaps [28]. Some key elements of public places include the public amenities that have been built there. Transportation systems for accessing diversified green infrastructure that represents the essence of public space can be merged with all-inclusive designs to suit every resident's demand in an integrated framework for a resilient city [29].
3. **Ensuring Community Participation in Development:** The participation of communities in sustainable urban recycling and heritage management ensures that the local projects are in harmony with their needs, values, and aspirations while creating ownership and inclusion [30]. With core communities, which use engagement tools like workshops, public consultations, and visualization technologies, in collaboration with broader communities like experts, governments, or NGOs, meaningful collaboration occurs toward improving decision-making processes. International frameworks like the UNESCO Historic Urban Landscape approach give special emphasis on active participation, awareness creation, and capacity-building to ensure that heritage preservation remains community-centered, sustainable, and reflective of their shared cultural identities [31].
4. **Community Well-being:** It combines enjoyment, health, and social connection among individuals and society as a whole, as well as resilience fostered by personal relationships, support networks, and broader community interactions [32]. Heritage is an important feature because it fosters identity, promotes mental health, encourages active activities like walking, and reduces violence in a city's historic cores, resulting in safe and harmonious urban environments. Coming into direct contact with heritage can also benefit elderly people's cognitive and emotional well-being by reinforcing their own memories and lowering the stress of social engagement, establishing relationships that are supportive of overall healthy living [33].

The Economic goals of sustainable urban recycling in historic cores have implications for healthy local economies and cultural identity. For example, encouraging businesses such as history tourism, artisan markets, and other place-based retail creates a confluence of several stakeholders, most notably citizens and tourists. Market and retail space demonstrates native culture in the area, attracting more interested visitors to spend time and money while also contributing to economic sustainability. This entails recognizing the requirements of communities that rely on traditional industries in order to promote inclusive growth. Such an equilibrium can result in lively historic cores turned into dynamic economic hubs while retaining their cultural integrity [5]. The following are the economic goals of historic cores:

1. **Stimulating Local Economies:** Stimulating local economies within historic cores promotes economic development while preserving heritage by making the most of their unique architectural, locational, and cultural characteristics [34]. Small entrepreneur incentives, training, and resources will be provided to revive traditional markets, various types of mixed-use developments, and the adaptive reuse of historic commercial buildings for commercial purposes. It will divide them from outside influences, providing the city with not only short-term resilience but also a long-term foundation for flourishing, self-sustaining urban environments [35].
2. **Increasing Property Values:** Sustainable urban recycling, in historic cores, modernizes under-utilized spaces and restores heritage buildings in order to increase the property value, thereby enhancing the aesthetics and functionality of spaces for both residential and commercial purposes. While most studies show contrasting results, the majority indicate positive price effects, primarily dependent on heritage sites that add to the increased demand and property premiums based on their cultural and historical value. The infrastructural upgrading, and improvement of public spaces,

amenities, and facilities, will attract businesses, tourists, and investors; contributing to the economy and creating lively, sustainable urban environments [36].

3. **Promoting Tourism and Cultural Industries:** Tourism in the historical cores provides considerable economic benefits such as job creation, enhanced economic activity, and so on with the collaboration of stakeholders such as tourists, hotels, businesses, the government, and local community members [37]. Cultural tourism is viewed as one of many fastest-growing global sections benefiting from festivals, cultural assets, and novel service offerings that enhance the visitor experience, stimulate publicity for the cities, and create a sustainable urban recycling framework [38]. The interaction between the tourism and cultural industries—technology and creativity as the backbone of this integration—effectively complemented each other in the economy as well as diversified the value of cultural products and the space transformed tourism itself into a knowledge-intensive, high-teched sector [39].
4. **Creating Jobs and Supporting Small Businesses:** Inclusive economic growth through formal employment opportunities in the cities is mainly focused on youth and marginalized groups through sustainable urban recycling at historic cores. To ensure the creation of equitable and secure working environments, these initiatives would bring cultural, social, and natural capital to the heritage site responding to the creative industries, small businesses, and tourism-related activities while maintaining historical integrity but also building economic resilience [35]. The general principles would include increased economic inclusivity, small businesses representing the character of the locality, empowerment of communities with decision-making authority, and a diversified industry as a measure of attaining sustainable and long-term economic health [40].

4 Case Studies

Achieving the environmental, cultural, social, and economic goals is the current approach of many countries for preserving historic cores instead of achieving one goal or two. All the goals of sustainable urban recycling are integrated and interconnected, achieving one goal will contribute to achieving the other one and this explains how the sustainable urban recycling process is a holistic approach. Achieving environmental improvements in historic cores will have an impact on and protect the architectural heritage from damage and decay, hence preserving the urban and cultural character. This will result in a direct impact on the community's well-being and cohesion, as well as individuals' sense of cultural belonging. These achievements will immediately improve livable public spaces, which leads to stimulating the local economy, raising social status, and providing different job opportunities.

This paper explores the multidimensional complexity of establishing a comprehensive practice for sustainable urban recycling in areas with historic tissue. Accordingly, the paper aimed to determine a successful site in terms of “sustainable urban recycling in historic cores.” The alternatives in this paper refer to the Two case studies, Bologna Historic Core Italy and Historic Cairo Egypt, and two types of samples for these case studies which are International, and Egyptian. These two case studies are among the most successful historical cores for achieving sustainable urban recycling goals, and analyzing them demonstrates how these goals enhance heritage preservation while also fulfilling the needs of current and future generations.

Selection of the indicators and sub-indicators is conducted by the relevant body of literature and the circumstances of the sites. There exist numerous approaches regarding the selection of indicators concerning the preservation and recycling of historic cores. The current paper approached the topic from



the main goals for sustainable urban recycling (environmental, cultural, social, and economic) and the indicators and sub-indicators for each.




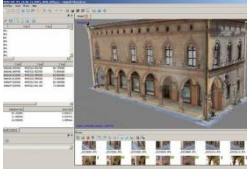
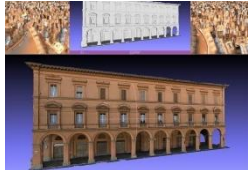
4.1 Bologna Historic Core, Italy





The porticoes of Bologna are a selection of 12 porticoes that reflect the different architectural typologies found in the overall 62km of Bologna's porticoed pathways, the largest porticoes system in the world. The 12 parts enshrine the typologies, architectural features, urban, and social functions that characterized the progressive enlargement of porticoed pathways in the city's central and peripheral areas, with the sustained renewal of a centuries-old tradition launched with the 1288 Statute [41].



Three institutions, cooperating to develop the whole system, integrate their perspectives within a common methodological approach: The Architecture Department of Bologna University is devoted to the creation of 3D models; the Municipality of Bologna will operate throughout the Open Data framework, already hosting 3D data related to the history of the city; CINECA is developing the platform. The planning process always moves around the objectives of growth and enhancement of the resources available in the planning area. The UNESCO Management Plan was decided to give priority to actions that result in growth and enhancement in the context of sustainability and to continue to guarantee the quality of life, environmental quality, inclusiveness, and usability of the cultural heritage, coordinating investment and funding in ways that are beneficial for overall city growth. The management plan included new ways of collaboration among users and stakeholders in order to increase cultural heritage production, improve the economic and environmental sustainability of the area in terms of commercial diversification and climate change response (both with mitigation and adaptation measures), and the accessibility of the area for every person, including people with disabilities, tourists, citizens, and students, by developing new cultural routes and making hidden treasures known. (Table 1) highlights the achievements of the different initiatives related to the goals of sustainable urban recycling in the historic heart of Bologna. The table discusses this through main indicators and specific sub-indicators [42].

Table 1. List of indicators and sub-indicators of sustainable urban recycling goals in historic cores, by the researcher.

Goals	Indicator	Sub – Indicator	Achievements	Pictures
	Resource Conservation and Efficiency	The alignment of restoration projects with historical architecture; minimal resource use with maintenance demands	Restoration projects were aligned with the historic architecture; traditional materials were successfully incorporated into the restoration efforts, ensuring longevity and authenticity. Minimal resources were used, ensuring minimal waste, but high maintenance was still required [41].	
	Minimizing Construction and Demolition Waste	Prioritization of adaptive reuse over new construction; strategies for waste reduction during renovations	There has been a significant reduction in waste generation through adaptive reuse strategies, and the preservation of the integrity of historic buildings [41].	

Environmental	Reducing Carbon Footprint	Implementation of energy-efficient solutions and promotion of public transport options	Pedestrian-friendly design through porticos and the use of eco-friendly transportation reduces reliance on vehicles, lowering emissions and improving the air quality in historic cores [41].	
	Improving Infrastructure	Upgrades to public spaces and utilities; enhancement of pedestrian pathways for improved mobility	Streets were repaired to improve pedestrian safety and mobility; modern lighting systems were installed and underground utility systems have been upgraded which have improved accessibility for residents and visitors and promoted a more attractive urban environment [41].	
	Promoting Circular Economy Practices	Reuse and recycling initiatives for historic buildings and public spaces	Some of the principles of the circular economy were achieved in urban planning through the reuse and recycling of historic buildings and public spaces which led to enhanced resource efficiency [42].	
	Integrating Energy Efficiency in Historic Buildings	Efforts to incorporate energy-efficient solutions into historic structures while preserving aesthetics	Limited progress and further initiatives are needed to achieve energy efficiency goals while respecting the integrity of historic buildings [42].	
	Preserving Architectural Heritage	Adherence to preservation guidelines for maintaining the integrity of historical sites	UNESCO guidelines have been followed and the integrity of the historic arcade structures has been preserved through their revitalization and reuse while enabling modern usage [42].	
	Digital Tools for Heritage Conservation	The alignment of restoration projects with historical architecture; minimal resource use with maintenance demands using 3D digital tools	The restoration processes included the usage of digital tools such as the developed pipeline project and many other tools were used in different projects such as 3D digital models representing as-built architecture, 2D textual and iconographic materials, and the Development of a new web-based architecture that allows multi-user customized access to different layers and opens to cultural and promotional cross-media further applications [43].	 

Cultural	Maintaining Urban Identity and Continuity	Efforts to retain traditional architectural styles and urban layouts amidst modernization efforts	Porticoes are iconic to Bologna's identity; the preservation of their layout, materials, and appearance helped in maintaining their identity and the functional integration with modern urban use helped in their continuity which enhances pride among the population [42].	
	The Role of Cultural Tourism	Development of tourism strategies that highlight the cultural heritage and promote local business	Porticoes are iconic to Bologna's identity; the preservation of their layout, materials, and appearance helped in maintaining their identity and the functional integration with modern urban use helped in their continuity which enhances pride among the population [42].	
Social	Enhancing Community Cohesion and Cultural Identity	Increased social interaction among residents, fostering a sense of belonging and cultural identity within the community	Local festivals and events under the porticos strengthen communal ties [42].	
	Livable Public spaces	Creation of accessible public areas that cater to diverse user needs; enhancement of green spaces	Porticoes offer protected public spaces that are accessible to all users with different needs [42].	
	Ensuring Community Participation in Development	High levels of community engagement in preservation efforts; local input valued in the decision-making process	There was high community engagement in preservation efforts, such as the participatory processes in the Rock Project, which brought together a large number of key stakeholders, including universities and non-institutional urban actors, that provide more accessible and inclusive public spaces for different users [42].	
	Community Well-being	Enhanced physical health and social well-being among residents due to improved public amenities and community activities	Community well-being is achieved through revitalizing the historic core by meeting the needs of different users of all ages, promoting socializing through public spaces, and improving physical health [42].	
	Stimulating Local Economies	Economic benefits derived from tourism and support for local businesses linked to heritage preservation efforts	Porticoes area generates income through tourism, supporting the local economy and commerce [41].	
	Increasing Property Values	Rising property demand due to heritage value; challenges related to affordability for locals	Property demand remains high due to heritage value but has become cost-prohibitive for locals [41].	





Economic	Promoting Tourism Industries and Cultural Industries	Growth of tourism-related businesses that leverage cultural heritage; support for local artisans	Draws significant tourism due to UNESCO status, benefiting the local economy and cultural industries [41].	
	Creating Jobs and Supporting Small Businesses	Initiatives aimed at supporting traditional craftspeople and small enterprises within the historic core	Porticoes support traditional businesses and artisans, driving local commerce that helps create jobs and support small businesses [41].	

4.2 Historic Cairo, Egypt

Historic Cairo is one of the world's remarkable cities, characterized by the incredible preservation of its architectural, cultural, and urban heritage, which completely shows its long history and diversity of values. Its location at the historic crossroads of international trade routes from Europe, Asia, and Africa contributed to its success as a political, cultural, and economic center, a destination for scholars, and a stop on important pilgrimage routes. The historic center of Cairo encompasses all the main components of the property including the historical street patterns and monuments (fortifications, historical buildings, urban fabric) that embody the city’s many different cultural and architectural layers of history. The overall urban structure of Historic Cairo formed over more than 1300 years, including the diversity of patterns of neighborhoods, streets, squares, alleys, and paths, the diversity of historical and archaeological buildings, local architecture, markets, handicraft activities, customs, and traditions maintaining their original locations and has been largely preserved, and its recognizable skyline remains intact. Many growing conservation movements have led to a number of restoration and urban rehabilitation projects in and around the property that have led to some transformations of the urban fabric. (Table 2) highlights the achievements of the different initiatives related to the objectives of sustainable urban recycling in historic Cairo, Egypt. The table discusses this through main indicators and specific sub-indicators [44].

Table 2. List of indicators and sub-indicators of sustainable urban recycling goals in historic cores, by the researcher.

Goals	Indicator	Sub – Indicator	Achievements	Pictures
	Resource Conservation and Efficiency	The alignment of restoration projects with historical architecture; minimal resource use with maintenance demands	Partially achieved through recycling materials from demolished structures for reuse in restoration [46].	
	Minimizing Construction and Demolition Waste	Prioritization of adaptive reuse over new construction; strategies for waste reduction during renovations	The demolition and removal of buildings that are considered to be structurally dilapidated or randomly built and incompatible with the historic urban fabric are carried out within the strictest limits in order to ensure the survival of archaeological and heritage buildings [46].	

Environmental	Reducing Carbon Footprint	Implementation of energy-efficient solutions and promotion of public transport options	Partially achieved through the promotion of pedestrian zones and minimizing reliance on motorized transportation [44].	
	Improving Infrastructure	Upgrades to public spaces and utilities; enhancement of pedestrian pathways for improved mobility	The infrastructure is still dilapidated it needs more improvement and maintenance as the ongoing plan aims to [44].	
	Promoting Circular Economy Practices	Reuse and recycling initiatives for historic buildings and public spaces	Promoting adaptive reuse of restored monuments with income-generating activities that support the protection of the immediate surroundings, perhaps by testing the approach for adaptive reuse and circular economy [44].	
	Integrating Energy Efficiency in Historic Buildings	Efforts to incorporate energy-efficient solutions into historic structures while preserving aesthetics	Limited progress and further initiatives are needed to achieve energy efficiency goals while respecting the integrity of historic buildings.	
Cultural	Preserving Architectural Heritage	Adherence to preservation guidelines for maintaining the integrity of historical sites	A number of projects have been implemented, are ongoing, or are being planned to preserve heritage buildings and Islamic architecture [44].	
	Digital Tools for Heritage Conservation	The alignment of restoration projects with historical architecture; minimal resource use with maintenance demands using 3D digital tools	A framework, strategy, and plans were implemented but need more improvement and more successful steps to achieve the main goal [44].	
	Maintaining Urban Identity and Continuity	Efforts to retain traditional architectural styles and urban layouts amidst modernization efforts	Achieved through preserving the street layout and the building's architectural style [44].	
	The Role of Cultural Tourism	Development of tourism strategies that highlight the cultural heritage and promote local business	It was achieved through specific campaigns, comprehensive public relations, events, and multimedia strategies that promote the benefits of cultural tourism	
Social	Enhancing Community Cohesion and Cultural Identity	Increased social interaction among residents, fostering a sense of belonging and cultural identity within the community	Revitalizing public spaces for community interaction, such as Al-Moez Street, hosting events and activities such as those of the association Art d'Egypte, including "Night at the Museum" and "A Night of Art at Muizz [44].	
	Livable Public spaces	Creation of accessible public areas that cater to diverse user needs; enhancement of green spaces	Achieved through the conversion of open areas into parks and pedestrian-friendly zones [44].	
	Ensuring Community	High levels of community engagement in preservation	There is an inclusion of local stakeholders in urban planning and decision-making processes [44].	

	Participation in Development	efforts; local input valued in the decision-making process		
	Community Well-being	Enhanced physical health and social well-being among residents due to improved public amenities and community activities	It was partially achieved by the improvement of living conditions through better housing and access to basic amenities in some areas and through the connection with culture [44].	
Economic	Stimulating Local Economies	Economic benefits derived from tourism and support for local businesses linked to heritage preservation efforts	Support for traditional crafts and local artisans through the preservation and promotion of handicraft workshops [44].	
	Increasing Property Values	Rising property demand due to heritage value; challenges related to affordability for locals	Revitalization projects have attracted investment and increased property demand in rehabilitated areas [44].	
	Promoting Tourism Industries and Cultural Industries	Growth of tourism-related businesses that leverage cultural heritage; support for local artisans	A success achieved in a lively commercial district with shops and galleries which have primarily been reconstructed while keeping some original historic structures and architectural elements that help in tourism and cultural industries like Moez Street, Souk al Selah, Bab al-Wazir Street, and Khalifa Street [44].	
	Creating Jobs and Supporting Small Businesses	Initiatives aimed at supporting traditional craftspeople and small enterprises within the historic core	Creation of employment opportunities in restoration projects, tourism, and crafts industries [44].	

5 Discussion

The pointing system used in this analysis serves as a systematic approach to evaluate the achievements of sustainable urban recycling indicators across the selected case studies. This method quantifies the extent to which each indicator and its corresponding sub-indicators have been met, allowing for a clear comparison between the different historic cores.

According to the previously defined theoretical framework, each case study is assessed based on a set of predefined indicators. These indicators are derived from the overarching goals of sustainable urban recycling. (Table 3) shows the extent to which the indicators and sub-indicators were achieved in the selected case studies and how successful the sub-indicator is as a general approach to the main goal.

Table 3. Pointing System Results for Case Studies, by the researcher

Main Indicators and Sub-Indicators		Verification of the Selected Historic Cores			
		1	2	Total	Results for qualitative analysis
Environmental	Resource Conservation and Efficiency		●	1	Moderate
	Minimizing Construction and Demolition Waste	●	●	2	
	Reducing Carbon Footprint	●	●	2	
	Improving Infrastructure	●		2	
	Promoting Circular Economy Practices		●	1	
	Integrating Energy Efficiency in Historic Buildings			0	
	Total	3	4		
	6	6			
Cultural	Preserving Architectural Heritage	●	●	2	Strong
	Digital Tools for Heritage Conservation	●		1	
	Maintaining Urban Identity and Continuity	●	●	2	
	The Role of Cultural Tourism	●	●	2	
	Total	4	3		
	4	4			
Social	Enhancing Community Cohesion and Cultural Identity	●	●	2	Moderate
	Livable Public spaces	●		1	
	Ensuring Community Participation in Development	●	●	2	
	Community Well-being	●		1	
	Total	4	2		
	4	4			
Economic	Stimulating Local Economies	●	●	2	Strong
	Increasing Property Values	●	●	2	
	Promoting Tourism Industries and Cultural Industries	●	●	2	
	Creating Jobs and Supporting Small Businesses	●	●	2	
	Total	4	4		
	4	4			

The detailed analysis of the two chosen historic cores shows that Bologna, Italy's historic core achieved most of the environmental goals which helped in minimizing construction waste through adaptive reuse and minimal new construction, reducing carbon footprints by increasing pedestrian paths and activities, and the ongoing projects of the current infrastructure. However, there is a shortage in some goals like resource efficiency which needs more effort and planning, promoting circular economy practices which will help in reviving the historic cores while meeting modern needs, and integrating energy efficiency into historic buildings which achieve sustainability practices. The cultural and social goals were achieved successfully by providing a good quality of life for residents and preserving the heritage and the cultural identity of the historic core which directly affected the economic goals in a positive way that helped increase the growth of local economies and promoting cultural industries through promoting tourism and supporting small businesses.

Historic Cairo, Egypt, has proven successful in achieving sustainable urban recycling goals despite the shortage in some goals such as environmental goals which need more effort and development plan

to improve the aged infrastructure and integrate energy efficiency into historical buildings to help in achieving sustainability while a more successful effort was found in resource conversation, demolition waste, and promoting circular economy practices, however, more development plans needed to reduce the carbon footprint by increasing more pedestrian zones. The cultural goals were achieved by preserving the heritage, cultural and urban identity, however, more usage of digital tools will help in the conservation plans of historical buildings and public spaces. Historic Cairo needs a careful effort in planning to create more livable public spaces that help in community well-being and achieve all the needs of different users despite the implemented projects such as Al Moez Street, however, most of the stakeholders had the opportunity to participate in the development plan, and the enhancement of community and cultural identity was achieved. A huge success was seen in achieving the economic goals which helped stimulate economic growth, increase property values, create jobs and support small businesses of local crafts and artisans, and helped in prompting tourism and cultural industries.

From the discussion of the previous case studies, revitalizing historic cities through sustainable urban recycling indisputably adds notable value and physical vitality to the city and promotes its cultural heritage. In this perspective, urban recycling can be considered a path leading toward sustainability, as it often addresses many detrimental environmental problems, which have recently been considered characteristic of densely populated city centers. Culture's role in urban development strategies has been consolidated for the cultural identity, individual's sense of belonging, and the competing of the cities for visitors and investment on a worldwide basis. The social culture currently has been in the government's interest for the community's wellbeing and social inclusion and cohesion. The economics' role in developing, promoting, and sustaining economies for providing a better life for the community as a whole and the individuals, through the revenues from tourism, crafts, and artifacts and contributing to the sustainable development of a region and a country, in addition to influencing behavior and economic development. The concept of sustainable urban recycling in historic cores has been studied in this thesis as a holistic approach that preserves and revitalizes areas rich in cultural, architectural, and historical significance.

6 Conclusion

In Conclusion, the paper discussed a comprehensive foundation that lays the groundwork for an in-depth analysis of sustainable urban recycling's role in shaping resilient and vibrant historic cores for future generations including different goals that are integrated and complete one another. The environmental goals involve resource conversation and source efficiency which help in preserving the original materials and minimize the usage of new ones, minimizing demolition and construction waste in historic cores which prevents negative environmental impacts, reducing carbon footprints and integrating green infrastructure, improving the infrastructure of historic cores to maintain a good services and amenities for different users, promoting circular economy practices and integrating energy efficiency into historic buildings. The cultural goals include the preservation and conservation of architectural heritage which helps to sustain a long life for historic cores and their different components, maintaining urban identity and continuity which helps in preserving the urban identity of the culture in the present time and ensuring its continuity and the role of cultural tourism in preserving the culture and importance of a historic core. The Social goals aim to enhance community cohesion and cultural identity for a better social experience, livable public spaces that connect different groups of people and create for them livable areas, ensuring community participation in development that helps people to be a part of the decision-making process to ensure that all their requirements are fulfilled and community wellbeing which ensures that all types of people can benefit from the development and the overall

health, enjoyment, secure and social connection is achieved. The economic goals help stimulate local economies within historic cores by preserving the architectural heritage with different and mixed-use, increasing property values through preserving historical buildings and enhancing the aesthetics and functionality of spaces for both residential and commercial purposes and promoting tourism and cultural industries which helps in increasing the economic return of tourists and local cultural products and creating jobs and supporting small business which creates opportunities for youth and different types of people to ensure the creation of equitable and secure working environments which helps in the economic development. Finally, the sustainable urban recycling process within historic cores helps to maintain a healthy environment, preserve cultural heritage, live an equitable life, and foster the overall economy of society. In order to understand the importance of sustainable urban recycling goals in historic cores, a comprehensive practice for two case studies Bologna, Italy, and Historic Cairo, Egypt introducing two samples of International and Egyptian historic cores, was implemented to discuss the four goals, indicators, and sub-indicators of sustainable urban recycling. The two case studies showed that the goals are interdependent and must be achieved simultaneously for effective and positive impacts on the current community and future generations.

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