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# Brownfield Recovery as a Sustainable Economic Catalyst Through Repurposing, Circular Material Flows, and Community-Inclusive Urban Planning in Hazaribagh, Dhaka

*[1] **Faizah Rafsan** , [2] **Shayer Ghafur** , [3] **Dipannita Nandi**

[1, 2, & 3] Department of Architecture, Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh

[1] E-mail: rafsanfaizah@gmail.com , [2] E-mail: sghafur@bangla.net.bd, [3] E-mail: dipannita@arch.buet.ac.bd

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## ABSTRACT

This paper examines the sustainable viability of repurposing as a community-inclusive approach for brownfield recovery in Hazaribagh, Dhaka, a former leather-processing hub shaped by industrial relocation, environmental degradation, and top-down redevelopment pressure. It addresses a gap in brownfield discourse: the limited integration of environmental remediation, urban economic continuity, and multidisciplinary stakeholder participation in rapidly urbanizing South Asian contexts. While many redevelopment strategies prioritize land clearance, zoning conversion, or technical treatment, the spatial networks, embodied livability, and material practices that already sustain the area are often overlooked. The study explores how socio-cultural continuity and economic diversification can be sustained through place-based regeneration to mitigate spatial effects. Methodologically, it employs cognitive mapping grounded in Kevin Lynch's five city elements with space syntax analysis and overlaid stakeholder mapping to understand city memory, urban metabolism, and informal economic networks. Findings reveal an adaptive urban system already formed by ongoing circulation of waste, labor, and material reuse. Accordingly, the proposed framework integrates nature-based ecological restoration and circular economy strategies, converting waste into building components and repurposing tannery structures for artisan production and community infrastructure. The study concludes that incremental, participatory, and material-driven interventions can redefine brownfields as regenerative landscapes, providing adaptable models for inclusive transformation in these contexts.

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| Highlights: | Contribution to the field statement: |
|---|---|
| - Brownfield can help to mitigate safety issues and social vulnerabilities.<br>- Mapping reveals how city memory shapes regeneration priorities.<br>- Structurally viable tannery buildings are reframed as community and production assets.<br>- Waste recycling is linked with ecological remediation and temporary structure for repurposing plots. | This study contributes a place-based regeneration framework for Hazaribagh that connects brownfield recovery with local livelihoods, city memory, and ecological remediation. It shows how abandoned tannery infrastructure can be repurposed as productive community assets, offering planners a transferable approach for community-inclusive redevelopment in dense cities like Dhaka. |

*** Corresponding Author: Faizah Rafsan**
Department of Architecture, Bangladesh University of Engineering and Technology(BUET), Dhaka, Bangladesh
Email address: rafsanfaizah@gmail.com

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## 1. Introduction

Dhaka, the capital of Bangladesh, is among the world's most densely populated and rapidly expanding megacities and is projected to become the largest city globally by 2050, according to the United Nations' World Urbanization Prospects 2025. The city currently accommodates approximately 23.9 million people within a metropolitan area of about 300 square kilometres, resulting in a density of 23,234 persons per square kilometre and reflecting a 3.39% population increase since 2021(World Population Review 2026). As urbanization accelerates in developing countries like Bangladesh, the challenges posed by rapid population growth, rural-to-urban migration (informal settlements), unplanned infrastructure, inadequate drainage system and continuous deletion of green spaces, blue spaces and surrounding low lands are exacerbated by lack of proper urban planning, inefficient land utilization and land-use policies (Climate Resilient and Green Action Plan (CRGAP) For RAJUK for the Hazaribagh Area of the Dhaka South City Corporation (DSCC) 2024). These issues are intensified by urban sprawl and the increasing need for urban land, especially along the Buriganga River, which has historically been the focal point of the city's industrial development. Among the industries that have flourished in Dhaka, the leather-processing sector, particularly tanneries in the Hazaribagh area, stands out as one of the oldest and most significant contributors to our economy. Since its founding in the 1940s, Hazaribagh has undergone profound spatial and economic transformations over the past decades. In 2017, following prolonged environmental and public health concerns, the government mandated the relocation of tannery industries to Savar, leaving behind a significantly altered land that is now widely characterized as a brownfield due to extensive soil and water contamination, deteriorated infrastructure, and ecological degradation.

Despite this condition, Hazaribagh has gradually evolved into a decentralized hub of leather goods production, sustained by small-scale artisans and micro-enterprises operating within and around abandoned tannery structures. While this transition reflects local adaptability and embedded craftsmanship, persistent challenges remain, including limited access to formal training, environmental vulnerability, and declining biodiversity. The administration has proposed a comprehensive redevelopment plan covering approximately 187 acres, of which nearly 100 acres are officially designated as brownfield, representing top-down restructuring interventions. There are some key issues and gaps in this approach which disregard the morphological structure of the network. Beyond its material decay, Hazaribagh embodies a layered city memory shaped by decades of industrial labor, informal production, and community resilience. The imageability of the Hazaribagh- canal edges, dense pathways, landmark-adjacent social infrastructures, and mixed-use districts- continues to structure how residents perceive, navigate, and remember their city. This embodied livability, reflected in everyday practices of trade, social gathering, and waste recycling, contributes to a distinct spatial identity rooted in resilience rather than neglect. Field observations and stakeholder engagement reveal that current redevelopment strategies may disregard these lived experiences and collective memories, thereby threatening the continuity of socio-cultural identity. In response, this project explores how place-based regeneration can preserve and reinterpret city memory while balancing ecological restoration with economic stability. (Couch et al., 2011; UN-Habitat, 2024)



**Figure 1**. Left-Environmental Deterioration and Biodiversity Challenges; Source: Mahmud Jaman Ovi, bdnews24.com, Right-Hazaribagh's transformation from stench to style - crafted in leather; Source: The Business Standard.




**Figure 2**. Location of the Study Area in Dhaka Map;
Source: Climate Resilient and Green Action Plan (CRGAP) Report.

### 1.1 Brownfield Recovery as a Planning Strategy

Brownfield is commonly used to describe previously developed industrial or commercial land whose reuse is constrained by actual or perceived contamination (United States Environmental Protection Agency, 1996; Mehdipour & Nia, 2013). Later policy debates in the United States expanded the term to include property where redevelopment may be delayed by the possible presence of hazardous substances, pollutants, or contaminants (Thornton et al., 2007; Dixon, 2012). Over time, brownfield recovery has moved beyond a public health concern and has become a planning instrument for reconnecting degraded land with environmental improvement, economic activity, and social benefit (Smith, 2008). It may convert underused industrial parcels into housing, public space, commercial uses, or work environments, depending on local needs (Kang & Hua, 2007). In rapidly urbanizing Asian cities, this issue is especially relevant because industrial growth has often produced land contamination, fragmented infrastructure, and social vulnerability (Smith, 2008). International experience shows that post-industrial decline can also generate unemployment, insecurity, and neighborhood deterioration when abandoned sites remain untreated (International Economic Development Council, 2008; Smith, 2008). For cities in the Global South, however, these sites can become opportunities for urban growth, regeneration, and livelihood-oriented reuse when planning engages existing local conditions (Smith, 2010). Industrial-area reclamation studies further show that heritage, environmental, and socio-cultural strategies can support sustainable reuse of derelict sites (Loures & Panagopoulos, 2007).

Brownfield recovery can reduce pressure on greenfield expansion, improve neighborhood quality, and create new social, environmental, and economic value (Fumeaux, 2014). Wu and Chen (2012) argue that regeneration is shaped by each city's particular path, including interactions among its physical form, social structure, and governance practices. This means that brownfield strategies cannot be transferred mechanically from one context to another. For Dhaka, and particularly Hazaribagh, the relevance of brownfield recovery lies not only in land redevelopment, but also in addressing industrial memory, informal production, socio-economic dependence, and environmental risk within a single framework (Smith, 2010). Recent Bangladesh-based studies similarly connect urban regeneration with livability, mobility, and sustainable redevelopment outcomes (Haque et al., 2024; Raj et al., 2024; Raj et al., 2025).

### 1.2 Circular Economy as a Sustainable Solution

Much of the global economy still follows a linear pattern of resource extraction, production, use, and disposal, where materials lose value after a short period of consumption (Ellen MacArthur Foundation, 2013; Franco, 2017; Pitt & Heinemeyer, 2015). This model depends on the assumption that raw materials and disposal capacity are continuously available, an assumption that becomes increasingly problematic under rapid population growth and rising consumption (Franco, 2017; Pengra, 2012; Sauvé et al., 2016).

To address the limitations of this linear model, the circular economy framework promotes systems in which resources are recovered, reused, and kept in circulation for longer periods (Sauvé et al., 2016; Chowdhury, 2022). It therefore offers a practical sustainability approach that links material efficiency with environmental protection and economic value creation (Ghisellini et al., 2016; Kirchherr et al., 2017). The Cradle to Cradle concept is central to this thinking because it distinguishes between biological materials that can return safely to natural cycles and technical materials that need to remain within managed industrial loops (Braungart EPEA, 2018). The Ellen MacArthur Foundation's circular economy diagram, often known as the Butterfly Diagram, illustrates these interrelated flows of biological and technical materials (Ellen MacArthur Foundation, 2013). Circular economy transitions also depend on the involvement of social actors and the creation of economic returns that motivate long-term adoption (Ghisellini et al., 2016).

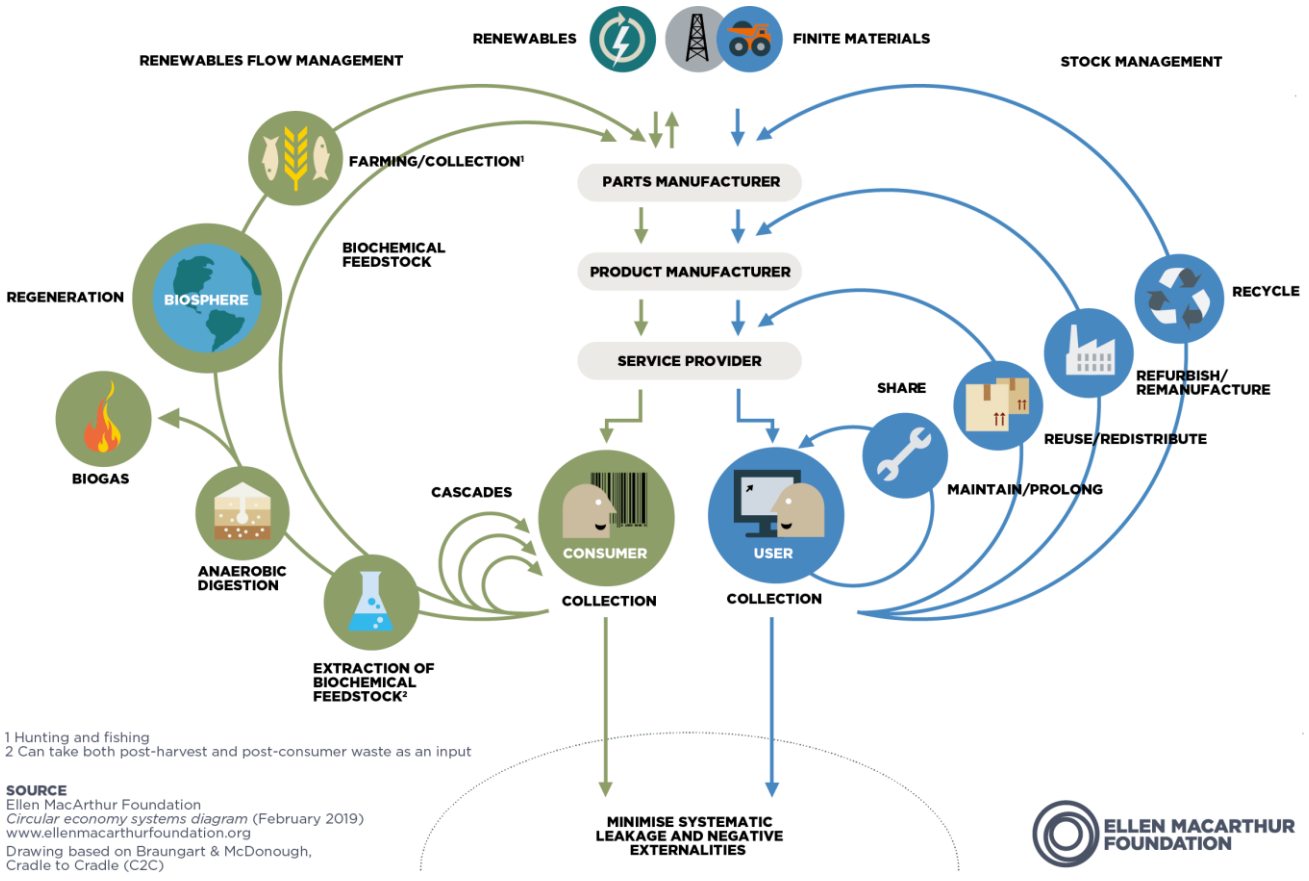


**Figure 3**. Circular economy systems diagram (Butterfly Diagram); Source: Ellen MacArthur Foundation (February 2019); Drawing based on Braungart & McDonough, Cradle to Cradle (C2C).

In this diagram, biological materials are understood as resources that can decompose and re-enter ecological systems, whereas technical materials such as plastics and metals require repeated recovery, repair, reuse, or recycling to retain their value (Ellen MacArthur Foundation, 2013, 2020). This distinction is important for Hazaribagh because the area contains both organic and inorganic waste

streams that can be linked to ecological recovery, building-material production, and local employment generation.

Applying circular thinking to brownfields allows derelict land to be read as a resource within an urban land-use cycle rather than only as a leftover of industrial decline. In dense cities, such sites often occupy central locations and retain infrastructure capable of supporting redevelopment, making them valuable alternatives to outward expansion (Loures, 2015). However, recovery should also address the soil and ecological systems connected to the site. Urban green spaces contribute to liveability through ecosystem services and can also support low-impact remediation strategies in contaminated environments (Wolch et al., 2014; Dickinson et al., 2000, 2009; Diplock et al., 2010). Gentle Remediation Options are nature-based approaches that manage contamination while seeking to maintain or improve soil function (Cundy et al., 2013, 2016). This creates scope for combining urban greening with circular land-use recovery, especially where soil restoration, community access, and productive reuse need to operate together (Chowdhury, 2022). This supports the interpretation of industrial brownfields as latent spatial, material, and economic resources rather than only contaminated land (Loures & Panagopoulos, 2007).

### 1.3 Repurposing as a Form of Community-Inclusive Revitalization

Repurposing refers to the transformation of existing buildings for new functions while retaining their structural integrity, material value, and spatial memory (Austin et al., 1988). Shen and Langston (2010) describe adaptive reuse as a process that gives an existing building a renewed function without erasing its basic fabric. In urban regeneration, this approach can reduce material waste, conserve embodied resources, and maintain cultural continuity, particularly when older industrial buildings remain structurally usable.

Adaptive reuse has been discussed through both professional conservation practice and academic research. From a conservation perspective, the Burra Charter supports compatible new uses where changes do not undermine cultural significance (Australia ICOMOS, 2013). UNESCO (2015) similarly emphasizes that new uses should respect the form, character, structure, and historic integrity of heritage buildings, while the City of Kitchener (2017) highlights careful adaptation through repair, alteration, replacement, and addition. In theoretical work, Burchell and Listokin (1981) frame adaptive reuse as a neighborhood revitalization process that inventories, manages, and re-employs surplus property to recover hidden real-estate value. The adapSTAR model also links successful adaptive reuse with streetscape quality, retention of old building character, structural clarity, conservation of significant artifacts, careful scale and material juxtaposition, user experience, suitable location, and long-term sustainability (Conejos et al., 2013). This positions repurposing as a neighborhood-scale regeneration mechanism that can reconnect abandoned property with social and economic value (Couch et al., 2011; UN-Habitat, 2024).

### 1.4 Research Gap, Originality, and Contribution

This study addresses the limited integration of brownfield remediation, socio-economic continuity, and spatial memory in regeneration research on South Asian megacities. Brownfield studies often emphasize contamination control, land-value recovery, or redevelopment finance, while urban design research tends to focus on morphology, public space, and spatial configuration. In Hazaribagh, however, ecological degradation, informal economic networks, material circulation, and collective memory are spatially intertwined, requiring an integrated regeneration framework.

The originality of the paper lies in its integration of three analytical lenses: mapping city image and memory to validate accessibility and movement hierarchy, and stakeholder-material mapping to reveal informal economic networks. This combined method enables the project to identify where ecological remediation, circular production, and repurposing can reinforce one another. The contribution is both methodological and practical. Methodologically, the study demonstrates how perceptual, configurational, and stakeholder-based analysis can inform brownfield regeneration. Practically, it

proposes a phased framework for transforming abandoned industrial districts while retaining local livelihoods, employment opportunities, and social identity.

## 2. Materials and Methods

The aim of this project is to develop a community-inclusive framework that links brownfield recovery in Hazaribagh to ecological remediation, economic continuity, and repurposing spaces within Dhaka's urban system. The following design objectives contribute to this aim by taking actions related to broader disciplinary goals of sustainable urban planning, repurposing, socio-ecological resilience, and preservation of local urban identity.

- To formulate brownfield recovery strategies utilizing nature-based solutions (NBS) and canal restoration through a phased masterplan generation
- To integrate circular economy mechanisms that convert waste into productive resources supporting the local economy and temporary construction systems
- To repurpose structurally viable tannery buildings to accommodate community-oriented public infrastructure aligned to stakeholder needs

### 2.1 Transition of Hazaribagh

Established in the 1940s, Hazaribagh tannery industry initially operated on about 62 acres and expanded steadily, particularly after Bangladesh's independence in 1971 (Biswas & Hamada, 2012; Khan, 2017; Azom et al., 2012). The area later emerged as the country's main leather-processing zone, with the Blacksmith Institute (2007) reporting around 270 tanneries (nearly 90% of tanneries) operationalized there. By the 1990s, Bangladesh had become an important producer in the global leather market, making a substantial contribution (Whitehead et al., 2019). This industrial concentration, however, created severe environmental pressure because untreated effluents from tannery processes were discharged into drains, interconnected canals, and the Buriganga River (one of the most heavily polluted rivers). Previous studies have linked tannery waste with high toxicity, heavy metal accumulation, groundwater contamination, and risks to aquatic ecosystems and human health (DoE, 2003; Koukal et al., 2004; Whitehead et al., 2018; Hasan et al., 2019). More than 200,000 residents have also been exposed through polluted water, contaminated food chains, and poor air quality, resulting in health concerns in the surrounding community (WHO, 2001; Fatema et al., 2018; Mohiuddin et al., 2016).

Efforts to mitigate the evidently increasing environmental impact of the tanneries in Hazaribagh began as relocation discussions began in the early 1990s (Karim et al., 2013; Mohiuddin et al., 2016). The area's industrial growth had occurred with limited planning control, and Rasul and Khan (2006) noted that 95% of the tanneries lacked adequate planning provisions. At its peak, the sector processed large volumes of raw hides and discharged untreated effluent daily, causing long-term damage to the Buriganga River and adjacent environments over 45 years (RAPID, 2019). As a result, in 2017, the government relocated the tannery industries from Hazaribagh to Savar. Following the established criteria, the combination of industrial abandonment, severely contaminated land, and economic uncertainty turns Hazaribagh into a brownfield site. However, the area has not become completely inactive: informal production, residual industrial activities, disorganized development, and weak waste management continue to shape everyday life. RAJUK's Climate Resilient and Green Action Plan (CRGAP) for Hazaribagh, prepared with support from the City Climate Gap Fund and GIZ Bangladesh, seeks to address redevelopment and environmental challenges through climate-resilient planning. The plan promotes nature-based solutions, green construction, pedestrian-friendly movement, blue-green spaces, block-based restructuring, and transport improvements.

## 2.2 CRGAP Study Area - Location and Geography

Hazaribagh is a densely populated area in Dhaka, Bangladesh, located west of the Buriganga River and bordered by areas such as Dhanmondi, Mohammadpur, and Kamrangi Char. The Hazaribagh Tannery District, a significant industrial zone until the tanneries were moved in 2017 pursuant to environmental concerns, is historically associated with the area. The concerned study area extends 182.74 acres and has a population of approximately 73,094 (BBS, 2011). The eastern portion of the study area has been crossed by "Sher-e Bangla Road," which appears to be a high-elevation. Thus, a natural slope runs between these two important routes and the Hazaribagh Canal. Specifically, the "Gojmohol" neighborhood area can be observed as the low height area closest to the Hazaribagh Canal.

### 2.2.1 CRGAP Proposed Initiatives and Policies

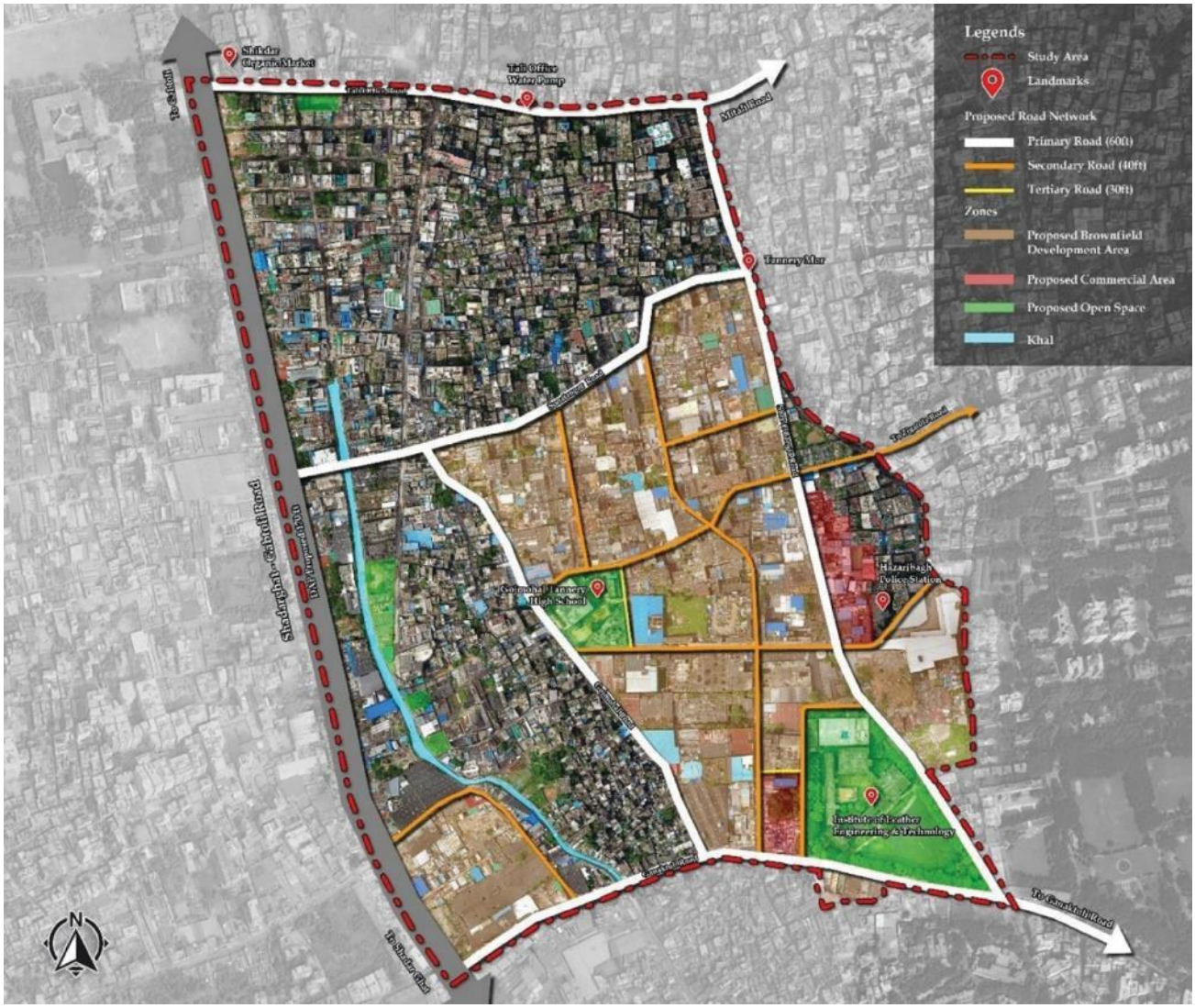


**Figure 4**. RAJUK/Government Proposed Masterplan of Hazaribagh;
Source: Climate Resilient and Green Action Plan (CRGAP) Report.




**Figure 5**. RAJUK/Government Proposed Initiatives and Policies;
Source: Climate Resilient and Green Action Plan (CRGAP) Report.

### 2.2.2 Key Issues and Gaps Toward the Government Proposed Top-Down Approach

Even though the environmental impacts of Hazaribagh are recognized, RAJUK's redevelopment plans primarily promote a top-down restructuring strategy focused on reconfiguring zoning, optimizing high-density land use, and formal green development policies. Although these initiatives mention climate resilience, nature-based solutions, and sustainable waste management, their implementation approach often prioritizes physical redevelopment at the expense of socio-spatial integration, disregarding marginalized populations in favor of the wealthy and privileged. The proposed framework fails to consider the current morphological network, informal economies, and the socio-cultural identities that are inherent in the local community. Such an approach results in three interrelated consequences within the city domain. Firstly, labeling Hazaribagh as a "brownfield" may remain purely theoretical rather than actionable, resulting in a mere symbolic ecological cleanup while contaminated environments persists. Secondly, extensive redevelopment risks erasing the shared history and economic strength that have long characterized the area. Lastly, spatial inequality, indicating redevelopment efforts that lack inclusive approaches, exacerbate the struggle for fair spatial distribution, risking the displacement of marginalized communities under the pretense of progress.

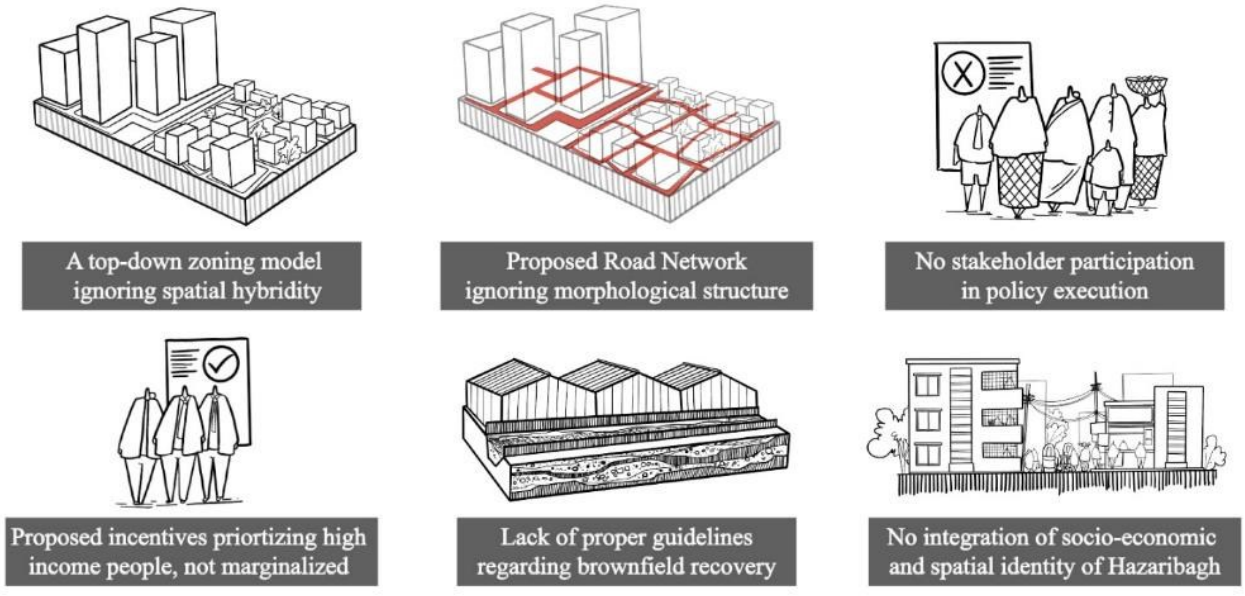


**Figure 6**. Key Issues and Gaps Toward the Government Proposed Top-Down Approach; Developed by the Authors.

## 2.3 Methodology

To mitigate the identified consequences of Hazaribagh within the city domain-spatial inequality, restructuring instead of preserving identity, inadequate treatment of brownfield conditions, and to address the research gaps, this study employs a layered qualitative-spatial and participatory methodology. The process starts with cognitive mapping to examine how the area is perceived, remembered, and spatially structured through everyday use. Kevin Lynch's five city elements-edges, paths, nodes, districts, and landmarks are used to read the morphological structure and imageability of the former tannery zone (Lynch, 1960). This preliminary approach provides a clear vocabulary for translating field observations into an urban design framework. Mapping is also treated as an interpretive and projective research tactic rather than a neutral representation, as it helps reveal hidden relations between movement, labor, contamination, and opportunity (Corner, 1999).

To validate these findings, a space syntax analysis is conducted to measure connectivity, accessibility, and spatial integration across the site. The space syntax analysis is further overlaid with stakeholder mapping obtained from interviews with multiple stakeholders to relate urban configuration with socio-economic realities. This combined method records the aspirations of primary, secondary, and tertiary stakeholders and guides design interventions through both spatial evidence and community priorities. A study of Egypt's New Urban Communities similarly drew on residents' and non-residents' perspectives to recommend that urban development policies "prioritize citizens' needs" (Kadry & Husain, 2024).

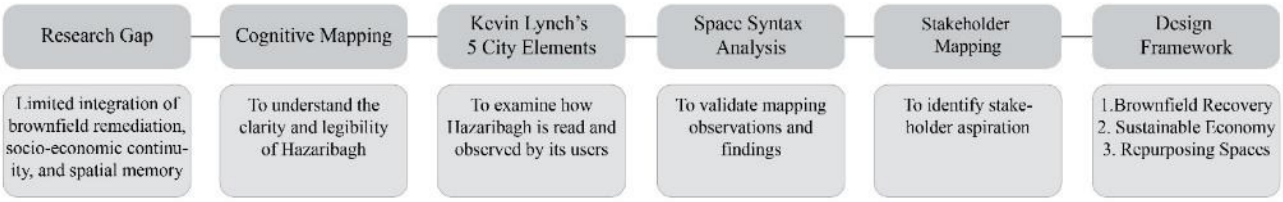


**Figure 7**. Methodological Framework.

Urban Planner Kevin Lynch's work on city imageability explains how people organize urban experience through mental images formed from recognizable physical elements (Lynch, 1960). In this study, the concept is used to examine how Hazaribagh is read and observed by its users after industrial relocation. Imageability refers to the capacity of urban form to produce a clear and memorable image for observers. Lynch identifies five recurring elements that structure this image:

(1) Paths are movement channels such as streets, lanes, or routes through which people travel and experience the city.

(2) Edges are linear boundaries or transitions that separate, contain, or connect different urban areas.

(3) Districts are areas with recognizable character, often shaped by dominant land use, activity, or spatial identity.

(4) Nodes are points of concentration or decision-making, usually formed by intersections, gathering spaces, or activity centers.

(5) Landmarks are visible reference points, symbols, or buildings that help people identify and remember a place (Lynch, 1960).

### 2.3.1 Cognitive mapping

Cognitive mapping is used to assess the clarity and legibility of Hazaribagh, as described by Kevin Lynch, to examine whether the area remains a fixed industrial image or is undergoing a dynamic transformation. This raises the question, "Is it a still image or does it go through a dynamic transformation?" A legible and well-structured city not only enhances orientation and wayfinding but also enriches the human experience, making the city more meaningful, livable, and memorable. Following this logic, the study area is divided into three primary enclosures: (1) Mixed Use Zone (predominantly industrial zone), (2) Gojmohol residential enclosure, and (3) Hazaribagh Canal. This

subdivision provides a basis for comparing spatial organization, environmental conditions, and socio-economic relations across the site.



**Figure 8**. Cognitive Mapping-Hazaribagh Khal (Canal Edge) Enclosure; Mixed-Use Zone (Former Industrial Core) and Gojmohol Residential Enclosure; Developed by the Authors.

**Table 1**: Observations and Findings of Cognitive Mapping; Developed by the Authors.

| **1. Mixed-Use Zone (Former Industrial Core)** | **2. Gojmohol Residential Enclosure** | **3. Hazaribagh Khal (Canal Edge)** |
|---|---|---|
| Character: Dense grid of abandoned tanneries, some appropriated informally as workshops or residences. | Character: A tightly woven community fabric, predominantly low-income, high social cohesion, adaptive use of narrow lanes and rooftops. | Character: Physically degraded, ecologically sensitive corridor. |
| Observation: Physically enclosed yet porous in function; many buildings decaying yet structurally present. | Observation: Strong sense of place and belonging; active street life; residents deeply attached to their homes and routines. | Observation: Once a vital water spine, now choked with waste and blocked flow; still spatially symbolic. |
| Layers: Strong industrial identity, smells, sounds, and toxic residues carry a heavy ecological imprint. Current Use: Informal trade, small-scale leather processing, intermittent storage. | Cultural Significance: Socio-cultural identity, craft knowledge, communal practices—collective memories at risk of disruption. | Community Use: Edge used informally for drying leather, washing, sometimes prayer or gathering; has potential as green and blue public space. Potentials: Preserving Ecological Corridor. |

In the mixed-use zone, cognitive mapping reveals a layered condition of decay and adaptation, while signs of industrial deterioration are evident, informal leather production, storage, and small-scale economic activities persist, indicating latent potential for adaptive reuse. In contrast, the Gojmohol residential enclosure demonstrates strong indicators of community cohesion and embodied livability. Despite being spatially enclosed between two brownfield edges, the neighborhood sustains vibrant social interactions, local networks, and resilient domestic economies. The Hazaribagh Canal, functioning as an ecological spine, now operates as a degraded edge and a back boundary to the residential zone. Field observations indicate significant loss of biodiversity and environmental quality; however, its linear continuity presents a critical spatial opportunity for ecological restoration and reconnection. The identification of major road networks further clarifies the interrelationship among these enclosures, revealing both physical disconnections and potential corridors for integration. Such mapping helps reveal latent spatial relations, informal practices, and place-based possibilities that may remain hidden in conventional plans (Corner, 1999).

### 2.3.2 Imageability of Hazaribagh - Kevin Lynch's 5 City Elements

To interpret the urban morphology of Hazaribagh, the study applies Kevin Lynch's five city elements- edges, paths, nodes, landmarks, and districts as an analytical framework to identify both strengths and structural deficiencies within the brownfield context.

**Edge:** For Hazaribagh, the primary edge is defined by the approximately 187-acre urban block, which operates as a significant urban boundary separating the dense, active city fabric from the abandoned tannery core. This edge demarcates a transition between vibrant residential-commercial life and the environmentally degraded brownfield interior.

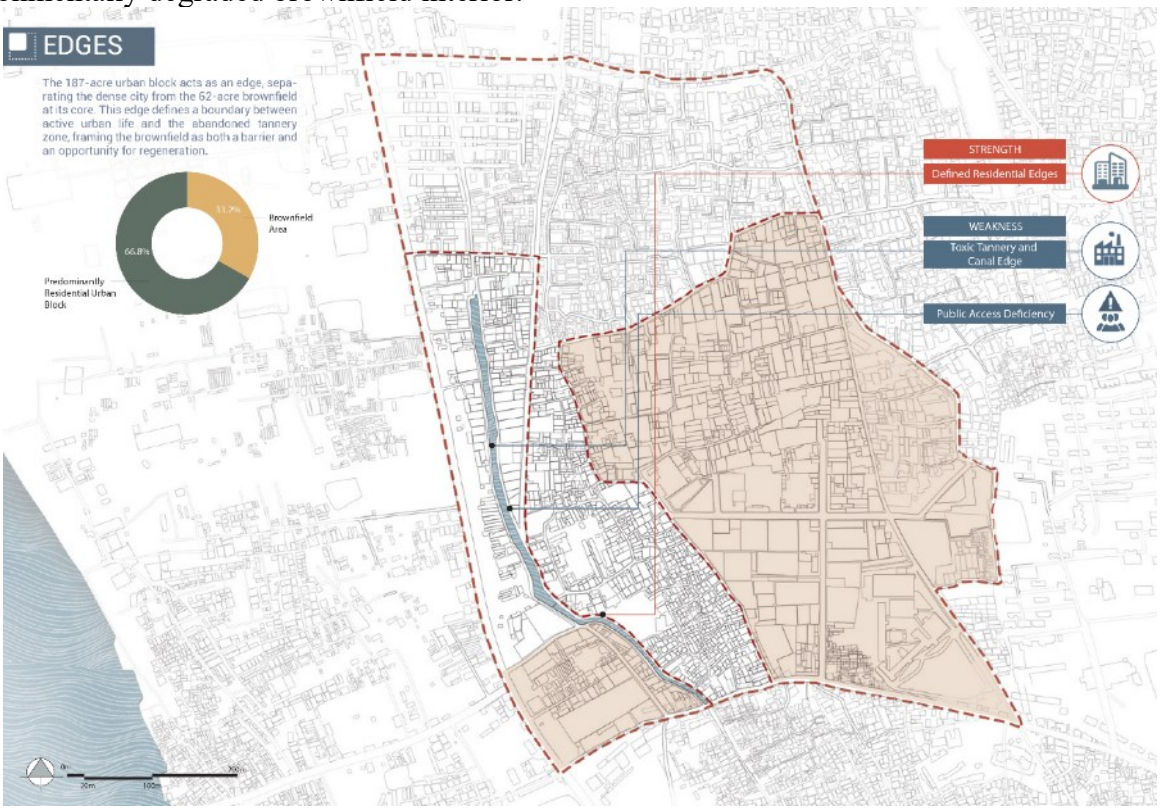


**Figure 9**. Identification of Edge; Developed by the Authors.




**Figure 10**. Identification of Path; Developed by the Authors.

**Path:** Hazaribagh is structured by four significant major roads- Sadarghat-Gabtoli Road, Tali Office Road, Hazaribagh Bazar Road, and Sher-e-Bangla Road, which collectively form a strong perimeter around the former industrial block. These routes reinforce the site's identity as a contained enclosure within the larger urban grid.

**Node:** Key nodes emerge at intersections of social, institutional, and economic activity, including Tannery Mor, the Hazaribagh Canal corridor, Gojmohol Tannery High School, Dhaka Tannery Mosque, and the Institute of Leather Engineering and Technology. These nodes serve as focal points for community gatherings and informal economic exchange.

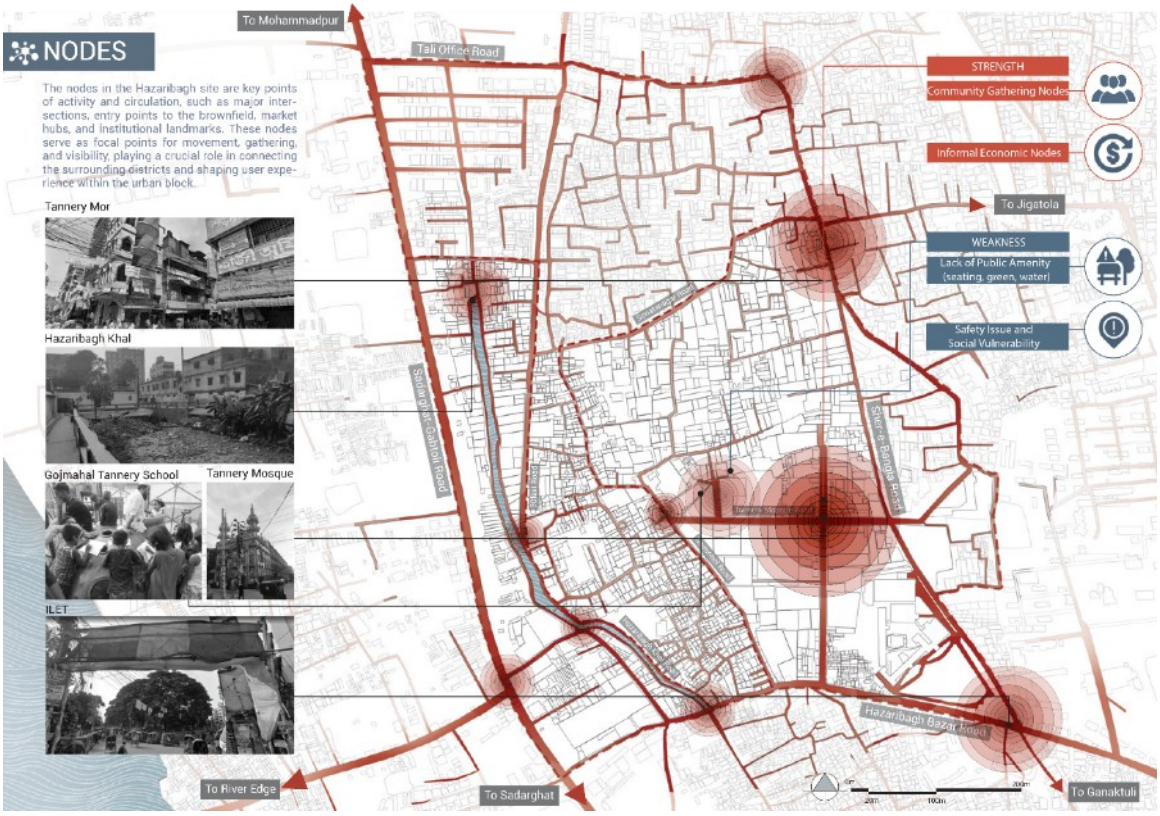


**Figure 11**. Identification of Node; Developed by the Authors.

**District:** In Lynch's framework, districts are recognizable urban areas that people identify through shared function, character, or activity patterns (Lynch, 1960). In Hazaribagh, five districts are identified based on observed land use and socio-economic activity.

1. In the mixed-use or brownfield zone, there is an area dedicated to leather product manufacturing, as well as for dry processing of leather, leather spare parts, and leather products (shoes, belts, wallets) making zone. Additionally, other activities observed in this area, beyond leather production, include courier services, storage facilities, rickshaw battery-charging stations, custom embroidery workstations, garment production, shoe manufacturing, and recycling factories.
2. The Waste Sorting zone, incorporating the STS, associated sorting and shredding zones, functions as a concentrated waste sorting and recovery area.
3. The commercial district, primarily along Sher-e-Bangla Road, consists of two types of retail stores: one is a leather shop, the other specializes in leather products and other miscellaneous retail shops along Hazaribagh Bazar.
4. The institutional area comprises Gojmohol Tannery High School and the Institute of Leather Engineering and Technology.
5. Additionally, the residential zone contains neighborhood pathways and spaces for social gatherings, which reflect a distinct identity and socio-economic structure within the community.

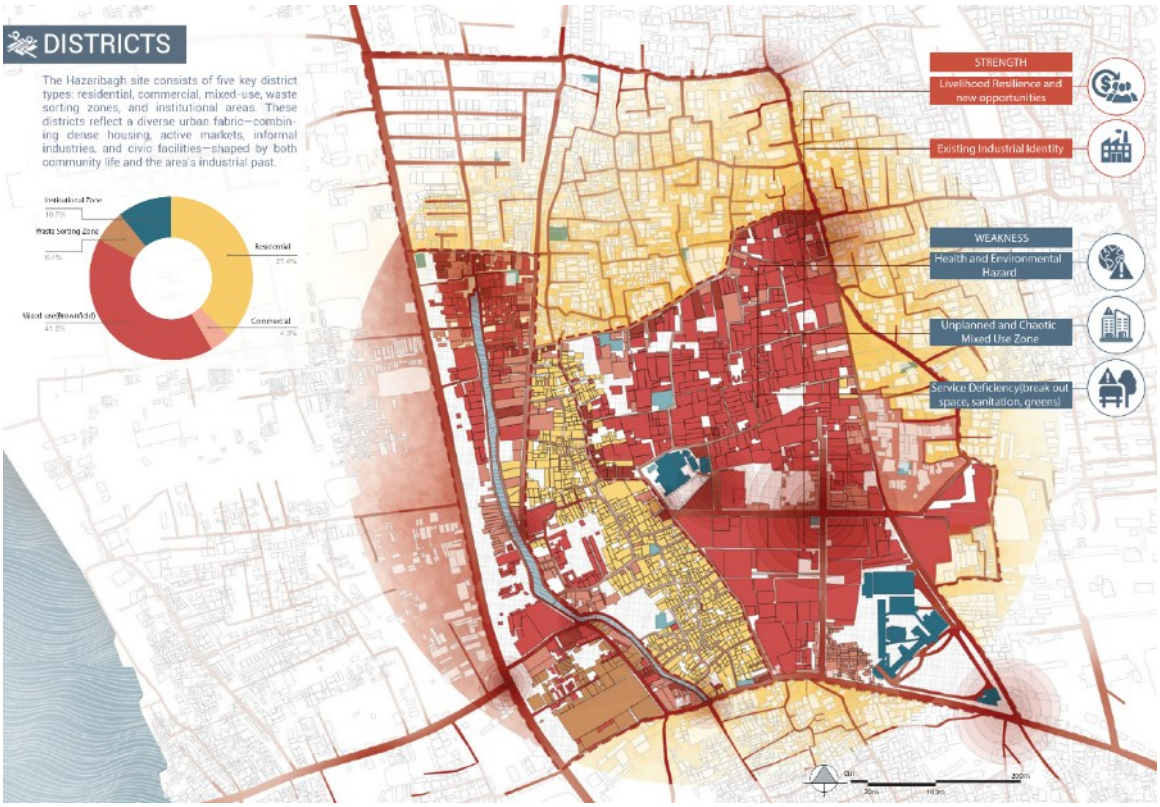


**Figure 12**. Identification of District. Developed by the Authors.

**Landmark:** Landmarks within the area primarily consist of social and institutional infrastructures embedded within major nodes, such as the mosque, school, police station, and educational institute. While these structures hold strong symbolic and community significance, they remain disconnected from a coherent public realm.

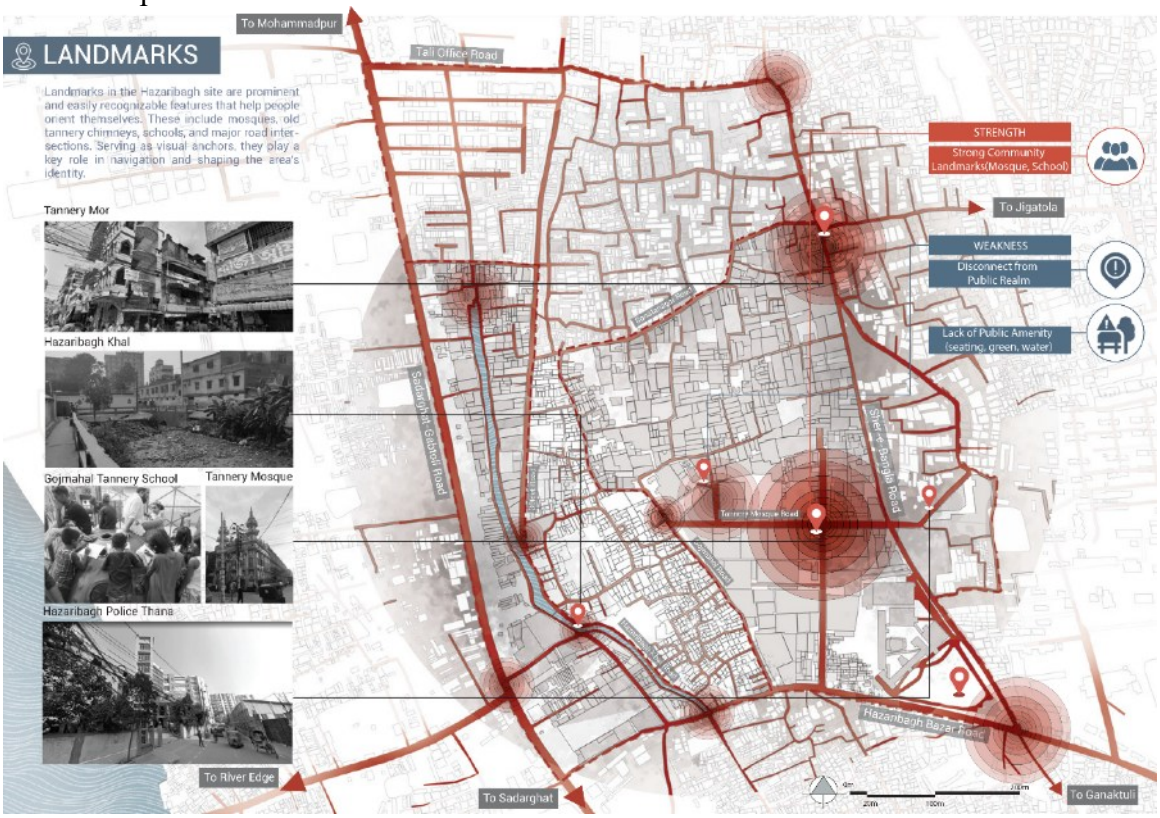


**Figure 13**. Identification of Landmark. Developed by the Authors.

### 2.3.3 Space Syntax Analysis

To validate and strengthen the findings derived from cognitive mapping and the five-city element framework, this study incorporates a space syntax analysis overlaid with stakeholder mapping, which evaluates the spatial network of Hazaribagh through three key parameters: connectivity, choice, and integration.




**Figure 14**. Space Syntax Analysis (Axial Analysis).

The results demonstrate a clear hierarchy within the study area. The north–south and east–west arterial roads exhibit high integration and high choice values, confirming their role as primary urban arteries and key movement corridors. These routes present strong opportunities for spatial stitching, active front development, and public interface enhancement. The south-eastern crossroad near Dhaka Tannery Mosque Road emerges as a highly integrated internal connector, functioning as a critical transitional node between residential and former industrial zones. Conversely, several segments display high connectivity but comparatively low integration and choice values, indicating locally active yet globally isolated spaces. Such areas are socially vibrant at a neighborhood scale but lack broader spatial influence, reinforcing patterns of enclosure and marginalization.

### 2.3.4 Stakeholder Mapping

The stakeholder mapping is conducted through a multi-stakeholder engagement process. Individuals interviewed during fieldwork are categorized into primary, secondary, and tertiary groups and spatially aligned with the syntax analysis outputs.

Primary stakeholders include local businessmen, members of the artisan community, entrepreneurs, informal workers, residents, women, children, youth, and students. Secondary and tertiary stakeholders comprise landowners, former tannery owners, non-governmental organizations, RAJUK, and GIZ. Stakeholders identify several shared aspirations and demands: effective environmental management, improved mobility networks, healthier working environments, diversified livelihood opportunities, adequate public amenities, strengthened social services, and spaces for recreation and learning. By synthesizing space syntax metrics with stakeholder aspirations, the study translates spatial diagnosis into programmatic direction.




**Figure 15**. Space Syntax Analysis overlaid with Stakeholder Mapping. Developed by the Authors.

## 3. Result- Design Strategy

The design strategy is formulated as a place-based framework that translates the aims and objectives into interventions grounded in the spatial context and emerges directly from the findings of cognitive mapping, space syntax analysis, and multi-stakeholder engagement. Instead of imposing an external redevelopment model, the strategy builds upon the imageability, morphological structure, and socio-economic networks identified within Hazaribagh.

The analysis of five city elements further clarified the morphological strengths and weaknesses, and validation through space syntax confirmed the connectivity and integrity of the pathways and nodes, while stakeholder mapping articulated community aspirations and access to public amenities. Integrating these findings led to the formulation of three primary design goals:

1.Brownfield Recovery

Nature-Based Solutions (NBS) supporting an ecological restoration approach, particularly in canal rehabilitation, green buffers, and urban forestry, consistent with regenerative urbanism practices.

2. Sustainable Economy

urban metabolism and circular economy guiding the integration of waste-to-resource systems, recognizing existing material flows as productive resources rather than residual liabilities

3. Repurposing Spaces

The concepts of adaptive reuse guide the repurposing of structurally viable tannery buildings, shifting from demolition to incremental transformation and participatory planning supporting a multi-stakeholder approach and ensuring that local aspirations shape spatial interventions (Husain & Salem, 2024).

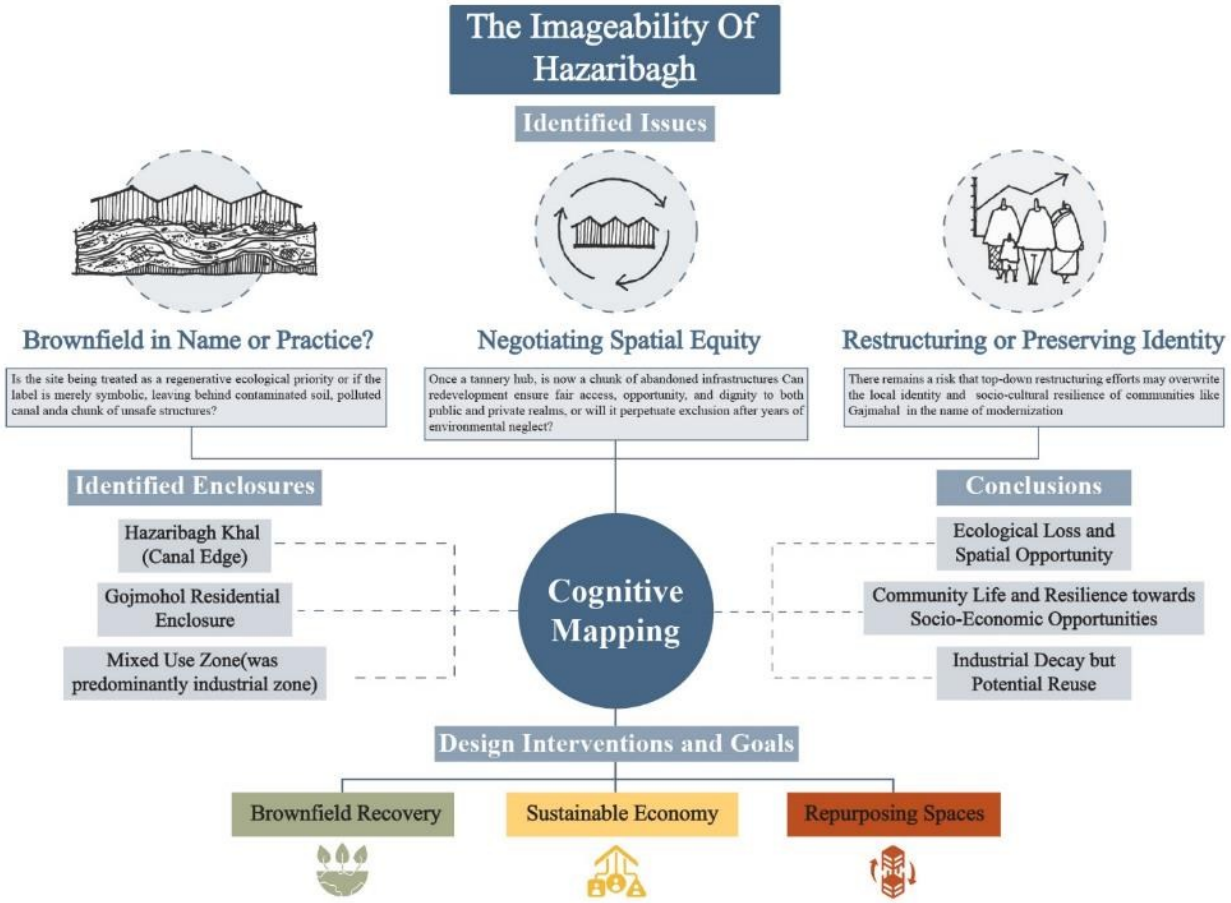


**Figure 16.** Design Goals and Strategic Priorities. Developed by the Authors.

## 4. Discussion

### 4.1 Masterplan Generation

The master plan for Hazaribagh is developed through a phased, adaptive design-iteration process structured to address the site's morphological complexities. Rather than proposing an immediate large-scale transformation, the strategy adopts a gradual transition framework that aligns with stakeholder aspirations, ecological remediation timelines, and the structural evaluation of existing tannery infrastructure.

Phase One prioritizes catalytic interventions along major commercial corridors and high-integration routes, focusing on initiating brownfield recovery through phytoremediation and soil stabilization. Selective repurposing of structurally stable tannery buildings is implemented to accommodate artisan production and micro-enterprise functions, ensuring continuity of local livelihoods during environmental restoration.

Phase Two progresses the transformation of the core brownfield zone. As the remediation process continues, previously contaminated areas are systematically converted into accessible green infrastructure, community spaces, and circular economy zones consisting of infrastructure built from recycled waste. This stage strengthens pedestrian connectivity and integrates canal-edge restoration, reinforcing the shift from an environmentally degraded industrial landscape toward a regenerative urban environment.

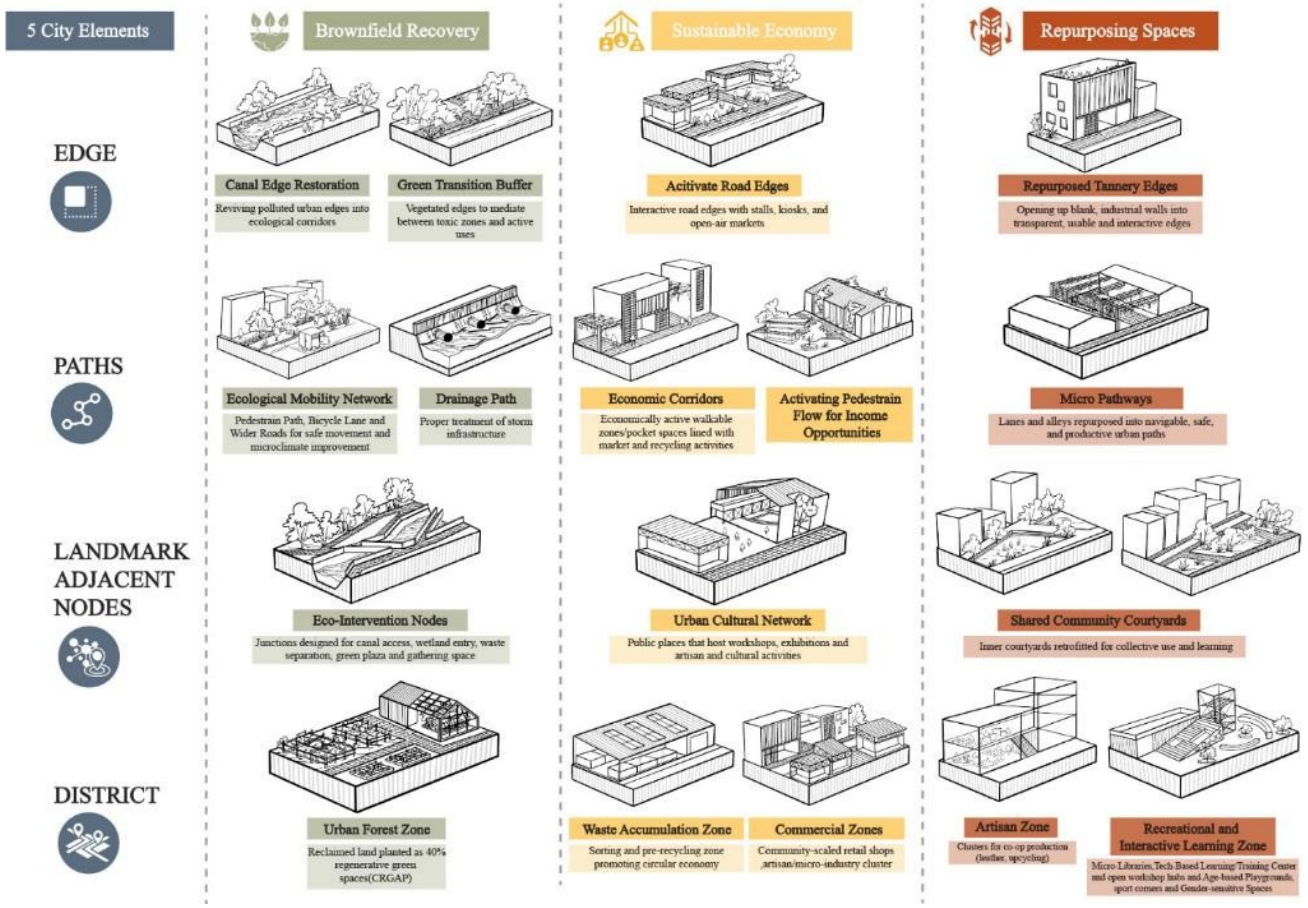


**Figure 17**. Design Intervention Framework. Developed by the Authors.

### 4.2 Masterplan Generation and Design Intervention Framework through 5 City Elements

The master plan is generated by embedding the three design goals into each of the five city elements, creating a multi-scalar intervention framework. The strategy is diagrammatically represented through color-coded layers that correspond to the three objectives across edges, paths, nodes, landmarks, and districts.

**A. Design Intervention in Canal and Road Edges**

The canal and the edges of the peripheral road are reimagined as regenerative interfaces rather than barriers. Interventions include Hazaribagh Canal Edge Restoration through ecological purification and biodiversity enhancement; a Green Transition Buffer that reduces environmental pollution; an Activated Economic Corridor along high-integration road segments; Structured Waste Accumulation Zones integrated into circular production systems; and the Repurposing of Tannery Edges to establish public-oriented, safe building fronts. These interventions transform the edge from a zone of exclusion into a productive ecological and economic threshold.

**B. Design Intervention in Path Connections**

Based on space syntax findings, highly integrated arterial roads and secondary connectors are strengthened through an Ecological Mobility Network that integrates pedestrian, vehicular, and drainage systems. Economic corridors are activated along high-choice segments to initiate active pedestrian flow, enhancing income opportunities. Micro-pathways within residential and mixed-use areas are enhanced to improve safety, permeability, and informal economic visibility. These interventions reinforce connectivity while aligning mobility improvements with stakeholder needs for enhanced accessibility and healthier working conditions.




**Figure 18**. Masterplan Generation. Developed by the Authors.

## C. Design Intervention in Landmark-Adjacent Nodes

Key nodes surrounding institutional and social infrastructures (landmarks) are redesigned as Eco-Intervention Nodes, incorporating green infrastructure, shaded courtyards, and shared community spaces. An Urban Cultural Network connects these nodes through pedestrian linkages, reinforcing collective memory and community engagement. Shared Community Courtyards (pocket parks) provide inclusive recreational and learning environments, addressing the identified deficit in public amenities and social services.

### D. Design Intervention in District Level Zoning

At the district level, zoning strategies align with the three design goals. Proposed districts include an Urban Forest Zone for ecological remediation, a Commercial Zone enhancing leather retail shops and Hazaribagh Bazar, a Waste Accumulation and Recycled Product-Making Zone structured around circular economy principles, a Recreational and Interactive Learning Zone promoting a safe and playful environment for children, and an Artisan/Micro-Industry Zone supporting skill development and small-scale production. These district-level interventions formalize existing economic networks while broadening opportunities for local stakeholders.

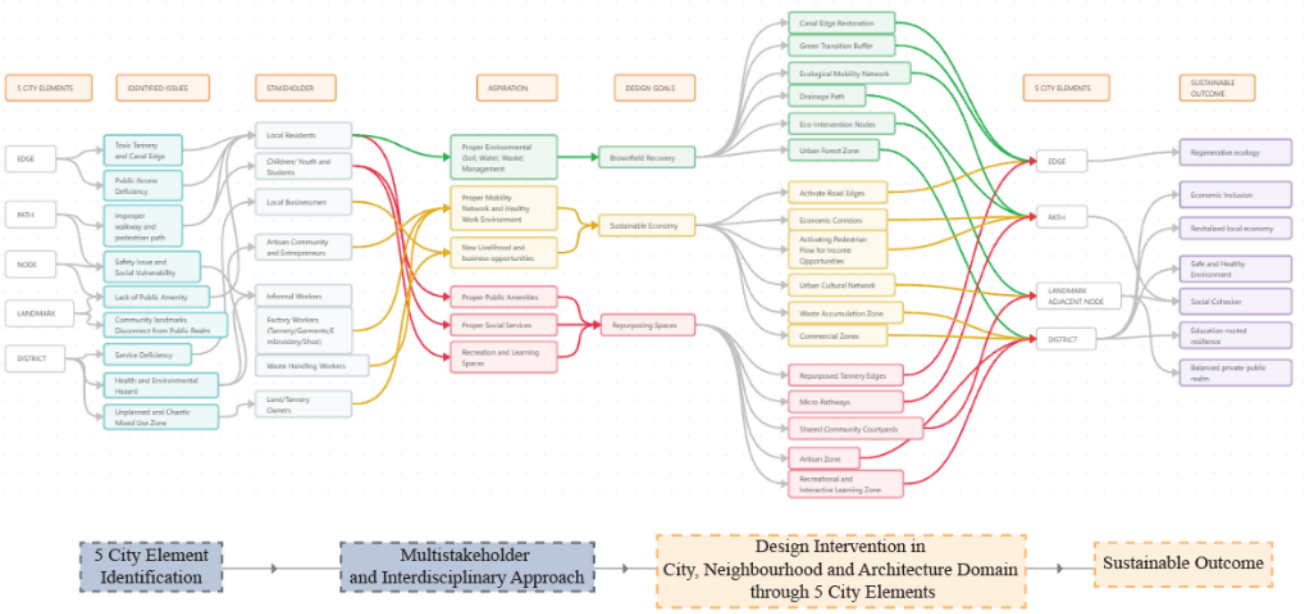


**Figure 19**. Masterplan Generation and Design Intervention Framework through 5 City Elements. Developed by the Authors.

### 4.3 Circular Economy Flow

The proposed circular economy flow organizes material recovery as a sequence of collection, sorting, processing, and reuse within the Waste Accumulation Zone, using abandoned tannery structures as productive infrastructure. Domestic and industrial waste from Hazaribagh, Kamrangi Char, and Mohammadpur is first brought to a designated receiving area, where it is temporarily held at the waste tipping station, and then moved to the primary sorting facility.

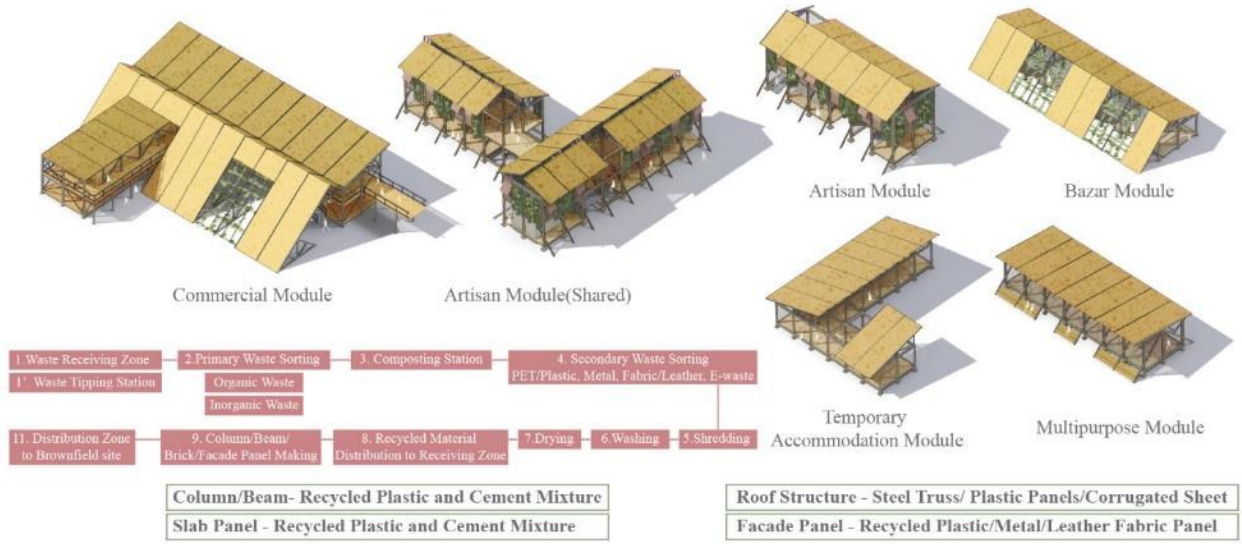


**Figure 20**. Circular Economy Flow (Recycled Modules). Developed by the Authors.

At the primary sorting stage, organic waste is separated from inorganic waste. Organic waste is processed through a composting station, producing nutrient-rich compost that is reintegrated into the Urban Farming Grid to support phytoremediation. Inorganic waste is redirected to a secondary sorting zone, where materials such as plastics, metals, fabrics, leather residues, and electronic waste are categorized and prepared for further processing. The subsequent shredding, washing, and drying operations occur within a controlled recycling unit designed to ensure material purity and reuse efficiency. Processed materials are either supplied to existing recycling networks in nearby areas or retained on-site for further transformation. A composite blend of recycled/shredded plastic and cement is used to produce recycled building materials, forming structural components such as columns, beams, slab panels, and facade modules. These components are assembled into modular systems, including commercial modules, temporary accommodation modules, artisan workshops, and multipurpose modules, thereby closing the material loop within the regeneration strategy. Structural elements such as columns and beams are designed as visible expressions of recycled construction, while roofing systems may incorporate either plastic panels or lightweight steel trusses. Facade treatments are developed using recycled plastic, metal, or leather fabric composites, and also allow for vertical green treatment of the recycled units and repurposed tannery buildings. Through this flow, waste is translated into architectural and economic value within the wider ecological recovery strategy. In this sense, the proposal extends circular economy thinking from waste management toward a spatial system of material recovery and local value creation (Ghisellini et al., 2016).

### 4.4 Urban Farming Grid and Community Recreation Space

This intervention formalizes the degraded canal edge condition by combining environmental remediation with structured public access. The designated Waste Accumulation Zone serves as a catalyst, embedding circular economy principles into the brownfield recovery process. Enhanced labor mobility, recycling infrastructure, and material production facilities are strategically integrated with adjacent residential areas and repurposed tannery structures to ensure spatial continuity and economic synergy. The Urban farming grid incorporates primary nurseries, phytoremediation landscapes, and soil restoration facilities, reinforcing the ecological transformation of contaminated land. The farming network supports urban agriculture and localized food production, aligning environmental repair with community participation. In addition, designated community recreation spaces function as ecological buffer zones, marked by native vegetation and productive landscapes that enhance biodiversity while providing accessible public areas. These spaces accommodate community gatherings, workshops, and learning environments, demonstrating how brownfield restoration can be formalized as multifunctional, productive, and community-inclusive space.

### 4.5 Urban and Socio-Economic Relevance

The proposed framework contributes to the urban economy in three ways. First, it repositions polluted and underused land as a productive public asset through phased remediation, reducing the need for demolition-led redevelopment. Second, the circular material-flow strategy creates a local value chain around waste collection, sorting, composting, production of recycled components, and artisanal work, linking regeneration with employment, skill retention, and micro-enterprise development. Third, improved paths, canal edges, and landmark-adjacent nodes can increase pedestrian visibility and customer access, supporting existing small businesses and informal services.

The socio-economic relevance of the project lies in upgrading environmental conditions without displacing existing livelihoods. Studies on Dhaka show that infrastructure or redevelopment-led interventions produce stronger outcomes when coordinated with land use, public space, and local economic needs (Raj et al., 2024; Raj et al., 2025). Similarly, regeneration research in Bangladeshi commercial districts indicates that improvements in livability should align with the daily practices of residents, workers, and traders (Haque et al., 2024). In Hazaribagh, green infrastructure and learning spaces should therefore strengthen, rather than replace, the existing artisan economy.

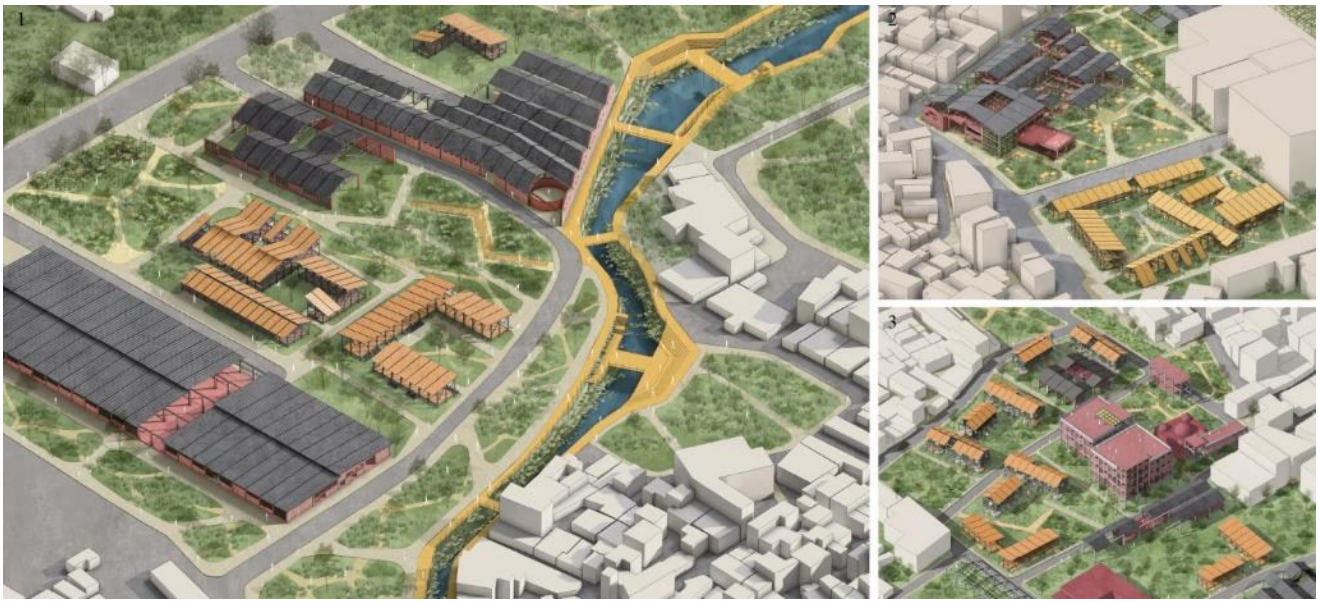

**Figure 21**. Design Iteration: 1. Waste Accumulation Zone, 2. Commercial District, 3. Artisan and Micro-Industry Corridor. Developed by the Authors.

## 5. Conclusions

This study demonstrates that Hazaribagh's brownfield condition should not be interpreted only as industrial abandonment or environmental contamination. The analysis shows that the area functions as an adaptive urban economy structured by leather micro-enterprises, waste sorting, and local landmarks. Cognitive mapping identified the canal edge, the mixed-use tannery core, the Gojmohol residential enclosure, and the institutional landmarks as key carriers of city memory. Space syntax analysis further confirmed that the main arterial roads and selected internal connectors are not only movement corridors but also potential anchors for economic reactivation. These findings support the hypothesis that brownfield recovery can become a sustainable economic catalyst when ecological remediation is linked to existing spatial and livelihood networks.

The proposed framework contributes to the literature by combining brownfield regeneration, circular economy, and repurposing into a place-based planning approach. Instead of proposing whole-site demolition, the study argues for phased transformation. The broader implication of this study lies in its contribution to urban regeneration discourse in rapidly urbanizing South Asian cities. It argues that post-industrial redevelopment should move beyond land clearance, zoning conversion, and technical remediation alone.

This research, however, has several limitations. First, the study is based on a single case of Hazaribagh; therefore, its findings are shaped by the area's specific industrial history, relocation, and stakeholder composition. The proposed framework may require contextual adaptation before it can be applied to other brownfield sites. Second, the study does not include detailed financial feasibility analysis, structural assessment of the tannery building, or technical soil and groundwater remediation testing. Third, the stakeholder analysis is based on selected field observations and consultations.

Future research should therefore conduct detailed environmental, structural, and economic assessments of selected tannery sites in Hazaribagh. Further studies may examine the feasibility of transforming tannery waste and other local waste streams into building components, including their cost, durability, health implications, and market potential, and also test the proposed framework through small-scale pilot interventions, such as the repurposing of one tannery building, canal-edge ecological restoration, or a community-based production hub. Comparative studies with other post-industrial areas in Dhaka and across South Asia would help evaluate the framework's wider applicability. Overall, this study positions Hazaribagh as a potential model for ecological, economic, and community-inclusive brownfield regeneration in dense post-industrial urban contexts.

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**Institutional Review Board Statement**
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