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DESIGN OF CULTURAL HERITAGE TRAILS BASED ON URBAN CATALYST THEORY: STRATEGIES AND APPROACHES

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*Abstract. **Purpose.** This paper addresses issues such as unclear spatial organization and insufficient integration with surrounding functions in the design of urban heritage trails. The main objective is to investigate the implementation of the widely applied urban catalyst theory in the practice of planning and design of cultural heritage trails, which will provide new perspectives and methods for theoretical research on the design of urban cultural heritage trails.*

***Methodology.** Through a comprehensive literature review, this study analyzes the developmental trends of heritage trails and the principles of urban catalyst theory. It employs case studies to identify the environmental design characteristics and critical factors influencing the effectiveness of heritage trails through the lens of catalyst theory.*

***Results.** The findings suggest that the design challenges faced by urban heritage trails can be effectively mitigated by adopting a spatial organization strategy that transitions from point-like elements to broader areas. The study delineates three key design steps: activating spatial nodes, ensuring continuity in spatial interfaces, and extending the urban context, supported by thorough case analyses.*

***Scientific novelty.** This research distinguishes itself by applying urban catalyst theory to address specific design issues within heritage trails, effectively summarizing and articulating relevant methods for practitioners in the field.*

***Practical significance.** The insights derived from this study provide a theoretical foundation and clear guidelines for the planning and design of future urban heritage trails, ensuring they are better integrated with their urban contexts and enhance cultural experiences for visitors.*

Keywords: heritage trail, urban catalyst, environmental design, streetscape design, cultural heritage, urban design, materials, colors, urban environment, design objects, street space, spatial perception, public space, tourism.

INTRODUCTION

Since the rise of land development models, represented by New Urbanism in the United States in the 1950s, traditional settlements and buildings in many cities worldwide have rapidly disappeared. New urban planning has

gradually replaced the old street textures and architectural styles. Some significant historical and cultural sites, as well as historically valuable urban public spaces, have been preserved as important concentrations of urban context and collective memory.

However, continuous urban construction has isolated these commemorative places in various corners, almost scattered in a point-like distribution. To a certain extent, this spatial fragmentation has damaged the continuity of the urban context and the legibility of the city's image [15]. For tourists and residents, it has become challenging to construct a recognizable and experiential cultural system. As a result, many cities have begun to emphasize the narrative of urban context, introducing the concept of the Heritage Trail, a planning approach from heritage tourism, into the design of urban street environments [3]. As a display interface for urban image, the Urban Cultural Heritage Trail is increasingly important in city branding and promoting regional development.

This design strategy not only revitalizes cultural heritage spaces and fragmented public spaces in the city but also enhances urban brand promotion and cultural dissemination. However, the design of Cultural Heritage Trails faces challenges, such as loose street textures, diverse types of heritage, unclear spatial organization, and conflicts between heritage sites and surrounding residential and commercial areas [14]. As a mature design theory that utilizes nodes to trigger chain reactions in surrounding spaces, the urban catalyst theory offers a theoretical solution to these conflicts by expanding from points to areas and from node spaces to overall spaces for urban heritage trails.

ANALYSIS OF PREVIOUS RESEARCH

After World War II, as the boom in large-scale infrastructure projects in the United States gradually subsided, the federally-led Urban Renewal Program essentially failed. The phenomenon of suburbanization spread across developed cities worldwide. Finding new paths for urban development became a common challenge for scholars, experts, and planners [12].

Against this backdrop, American scholars Wayne Attoe and Don Logan published their book *American Urban Architecture: Catalysts in the Design of Cities* in 1983, proposing the core idea of strategic intervention to enhance urban development. They argued that spatial renewal through public buildings, infrastructure, and other elements could stimulate changes in the surrounding environment, triggering a series of catalytic reactions to promote urban vitality and transformation [1]. This work laid the theoretical foundation for urban catalyst theory, which has since evolved under the influence of various disciplines, including design, architecture, sociology, and economics.

The term «catalyst» originally referred to a substance used in small amounts relative to the reactants in a chemical reaction, capable of altering and accelerating the reaction rate without being consumed in the process. Its conceptual evolution across different fields has been extended to mean «a factor that triggers or accelerates significant change or action, or an event or person that quickly causes change or action» [20].

Attoe and his co-authors pointed out in their book that «isolated» good design is insufficient; urban design should «respond to existing elements» and «guide subsequent elements» to achieve a sustainable process. «Catalyst» is a gradual, strategic, point-to-point planning and design method that is more reasonable, economical, and flexible.

In the context of urban development, introducing the concept of «catalyst» generally refers to «urban development activities» that can positively influence subsequent construction activities [7]. These can include «hotels, shopping districts, or transportation hubs; museums, cinemas, or designed open spaces; or even small-scale features such as arcades or fountains». It could also be «reports or design guidelines».

As urban catalyst theory has evolved and improved through half a century of practical application, it has extended to related studies such as Urban Regeneration Theory and Place Development Theory. However, urban catalyst theory is primarily applied in contemporary commercial buildings, landscape architecture, and specific location practices [6]. As a theory of strategic spatial intervention, its influence remains relatively limited.

This paper identifies the challenge in the spatial design of Cultural Heritage Trails concerning how to logically and narratively connect spaces. It integrates the strategic interventions and environmental chain reactions of urban catalyst theory into the planning research and design methods of Heritage Trails.

PROBLEM STATEMENT

Cultural heritage in urban construction often faces point-like distribution and spatial fragmentation issues. As a result, some designers and scholars have introduced Cultural Heritage Trails into environmental design to address the

problems of poor spatial continuity and weak visibility of heritage nodes and historical districts, effectively triggering the narrative mechanism of urban context. This design mechanism is conceptually similar to the theoretical system of catalytic theory in urban design.

Therefore, this paper aims to interpret relevant design cases of cultural heritage trails from the perspective of urban catalytic theory. By deconstructing the environmental design methods of heritage trails in terms of point-like catalysts, line-like catalysts, and area-like catalysts, it seeks to provide new perspectives for expanding the design practice of urban catalytic theory and offer new pathways for the design thinking of urban heritage trails.

THE RESULTS AND THEIR DISCUSSION

– ***Environmental Design Characteristics of Urban Heritage Trails from a Catalyst Perspective:***

Cultural Heritage Trails differ from historical heritage sites and the planning of historic districts; they are an implicit planning method that shapes an urban catalyst system through weak connections [19]. The key to guiding and controlling catalytic reactions in urban blocks lies in constructing a well-formed neighborhood space. This paper introduces a «point-line-plane» urban catalyst spatial system, where point-like catalytic elements form a linear catalytic framework, creating a planar catalytic spatial structure (fig. 1).

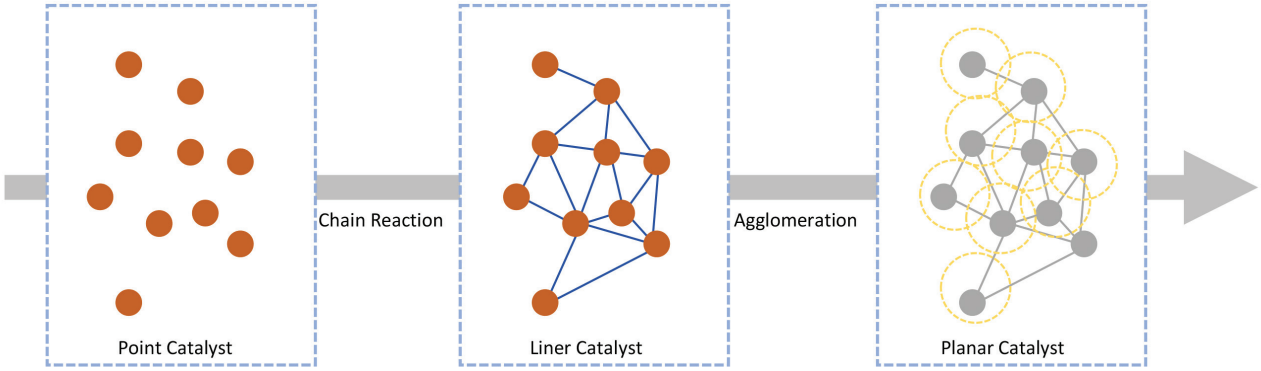


Fig.1. Construction Path of Spatial Form in Urban Catalyst (Figure credit: author's drawing)

From Point Catalysts to Linear Catalysts:

The most fundamental aspect of activating Cultural Heritage Trails is the point catalyst. Urban historical heritage typically manifests as singular historical buildings or art installations representing tangible forms. These point catalysts are characterized by their lack of directionality and discreteness, with relatively limited catalytic reach, making it difficult to create substantial spatial impacts. However, by utilizing the chain reaction of multiple-point catalysts and deliberately intervening in their distribution, a linear space can be formed with clear directionality. This can further clarify the catalytic effect within the neighborhood. The most typical form of linear catalysts is passage spaces such as streets or walkways. For example, a single-way-finding sign within a street functions as a point catalyst. In contrast, a series of strategically placed way-finding signs in a public space exemplifies the transformation from point to linear catalysts.

From Linear Catalysts to Planar Catalysts:

Once point catalysts have formed linear catalysts through chain reactions, the spatial configuration of Cultural Heritage Trails is significantly enhanced. As the catalytic effect further deepens and extends into the surroundings of the linear space, multiple linear catalysts can cluster together, forming a larger-scale planar catalyst, greatly enhancing the spatial freedom and options available for heritage trails. For instance, in the design of historical districts, different walking paths are often created based on various age groups and commercial themes. The intersection and dispersion of these linear catalysts generate a centripetal planar catalyst, which stimulates strong spatial vitality.

Characteristics of Point-Line-Surface Catalysts:

The spatial catalysts evolve and reshape the Urban Heritage Trail in the transition from points to lines to surfaces, reflecting three characteristics of the catalytic effect: cultural

characteristics, interactive characteristics, and resonance characteristics.

Among them, the cultural characteristics of catalysts (point catalysts) possess typological and replicable traits. For instance, the Hong Kong government has set up several bronze information plaques along the northern shore of Victoria Harbour on Hong Kong Island. Unlike traffic signage systems, these plaques record the changes in the coastline of Hong Kong Island due to land reclamation since the city's opening. This typological street furniture design that records urban history provides a spatial narrative design method for urban context [16] (table 1-a).

A similar example is the «Impressionist Island» (Ile de Chatou), located on the Seine River in Paris. This small island was a gathering place for Impressionists in the 19th century. Four cultural heritage paths surround Impressionist Island: the Monet Path, Pissarro Path, Renoir Path, and Sisley Path. Each path features different types of artwork plaques that showcase the masterpieces of these artists, continuously hinting at the thematic nature of the paths and the historical footprints of the artists. Each path is approximately 3–4 kilometers long and features over 30 artwork panels as informational cues along the trail [5] (table 1-a).

The interactive characteristics of catalysts (line catalysts) exhibit continuity and walkability. For example, Leipzig was an important cultural and artistic hub in Germany during the 17th to 19th centuries. However, today, music is merely a symbol of the city and does not contribute significantly to the development of public spaces. When applying for World Heritage status, Leipzig planned to promote its musical heritage as a brand and designed a music-themed path called the Notenspur (Note Path).

The Note Path is not a traditional linear guide; instead, it forms a line catalyst through continuous musical note markings on the ground. Unlike Boston's Freedom Trail, which features a red line, Leipzig embeds arc-shaped aluminum profiles into the brick paving to create a prominent guiding effect in public spaces. This urban narrative symbol guides visitors on an 800-year journey through classical music history, with stops at musicians' former homes, concert halls, museums, and more, making the city's image more tangible and perceptible. In 2016, the Note Path participated in the European Cultural Heritage Mark as the only project from Germany. It became an important public space and cultural symbol for Leipzig to showcase its musical culture to the world [10] (table 1-b).

Another example is the famous tram line (Ding Ding Tram) on the northern shore of Hong Kong Island. The route is 13 kilometers long, with a total track length of 30 kilometers, all located on the road. The trams do not have horns; they rely on a bell to alert pedestrians, producing a «ding ding» sound, hence the affectionate name. Today, the Hong Kong tram is not only a symbol of the island's prosperity but also retains its traditional design, with its color scheme and guiding design forming a cohesive system. Moreover, each station periodically features different thematic content. As urban construction continues to evolve, while city roads have shifted from a single transportation attribute to a more diversified trend, the rich transport modes in Hong Kong have significantly enhanced this. However, the Ding Ding Tram has been well-preserved and systematically updated due to its role as a window for the heritage transmission and display of the city's cultural narrative. The over-a-century-old tram line is one of the most crucial line catalysts on Hong Kong Island [17] (table 1-b).

The resonance characteristics of catalysts (surface catalysts) include openness and sustainability. For example, Tai Kwun in Hong Kong's Central and Western District Cultural Trail underwent 12 years of architectural updates and surrounding environmental revitalization, connecting several heritage paths in the area through resonant catalytic methods. The design of Tai Kwun transformed a former police station into a heritage and arts center, integrating vibrant public spaces within a historical heritage cluster, continually representing and interacting with the region's historical context, reflecting the sustainability of spatial design.

Similarly, Lutherstadt Eisleben used area renewal (surface catalysts) for the restoration design of urban cultural heritage paths. This small town staged many important events in Martin Luther's life and was listed as a UNESCO World Heritage site in 1996. To rejuvenate the city and enhance its international appeal, it combines local historical and cultural backgrounds through architectural spaces and artistic interventions, gradually establishing a new urban brand.

Initially, Springer Architects designed a series of public buildings, such as visitor centers, through the expansion and renewal of Luther's birthplace. These buildings showcase a clever approach to urban restoration, using materials that respect both local scale and urban cultural context. They are integrated into the historical district as spatial repairs, creating intersections and experiential points for different heritage trails. Simultaneously, the «Luther Path» is created through a thematic narrative, incorporating art and citizen activities. It fosters

diverse uses and experiences in public spaces through the ongoing involvement of designers, artists, and residents, providing prosperous and sustainable cultural attractions for the community [13] (table 1-c).

– ***Steps in the Environmental Design of Urban Heritage Trails Under Catalyst Theory***

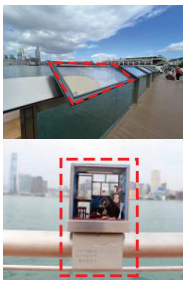
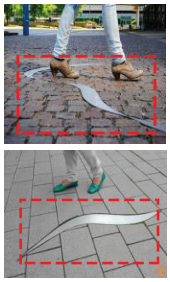
Based on the spatial organization method of point-to-line-to-surface in urban catalyst theory, this study summarizes three steps for the environmental design of heritage trails characterized by linear urban heritage spaces: first, activating spatial nodes; second, extending spatial interfaces; and finally, developing an extension of urban context, providing a new perspective on environmental design for the sustainable development of heritage trails.

Emphasizing the Activation of Spatial Node Design:

Historical buildings, sites of historical events, and other elements belong to spatial

Table 1

Characteristics and case studies of point, line and surface catalysts

	a. The cultural characteristics of catalysts (point catalysts)		***b. The interactive characteristics of catalysts (line catalysts)***		***c. The resonance characteristics of catalysts (surface catalysts)***	
Case	***Hong Kong coastal transition line***	***Impressionist Island in Paris (Ile de Chatou)***	***Leipzig Note Road (Notenspur)***	***Hong Kong Tram (Ding Ding)***	***Eisleben Martin Luther Heritage Trail***	***Central and Western Heritage Trail, Hong Kong***
Case Photo						
*DDesign Thinking**	*a)*	*b)*	*c)*	*d)*	*e)*	*f)*
Design Feature	*Typing and replicability*		*Continuity and walkability*		*Openness and sustainable development*	

* a) Bronze information boards have been installed along Victoria Harbour to record the changes in the coastline of Hong Kong Island under the continuous influence of artificial reclamation.

b) The way in which each of these painters' masterpieces is presented constantly suggests the thematic nature of the path and the historical trail of the painter. Each path is about 3–4 km, and about 30 painting panels are used as information clues to the path.

c) Leipzig used curved silver aluminum profiles embedded in the masonry floor to create a prominent guiding effect in the public space.

d) As a symbol of the prosperity of Hong Kong Island, Hong Kong trams not only continue the traditional shape, but also form their own system from color configuration to tour design. Different stations in each period will have different themes of content design.

e) The Martin Luther-themed architectural renewal demonstrates an ingenious urban restoration, using materials that respect both the scale of the place and the culture of the urban area, and are complemented in a spatial restoration to create a different situational experience in the historic district.

f) The design of Tai Kwun in Hong Kong began with the transformation of an abandoned police station into a heritage and art center, interweaving vibrant public Spaces into the architectural group of historical heritage, and recreating and interacting with the historical context of the region from beginning to end.

nodes. These nodes are essential components of important cultural public spaces within heritage trails. They are focal points in point catalysts, typically highlighting the cultural characteristics of the heritage trail within a relatively concentrated small space. Generally, the significant node spaces along heritage trails include entrances, transportation hubs, sites of significant historical relics, and points for cultural industry development. In implementing cultural catalyst strategies, the activation of these spatial nodes must be prioritized (fig. 2).

First, for the starting point of the trail, which is generally the most important external display face of the site's cultural image, the narrative of the trail's context should be distilled into a simplified model that reflects its value connotation and is manifested in the external space, reinforcing the cultural identity of the entrance. Second, the relatively expanded scale of corner spaces within various street spaces along the trail can be utilized to introduce cultural catalysts, forming distinctive cultural nodes that enrich the cultural experience during

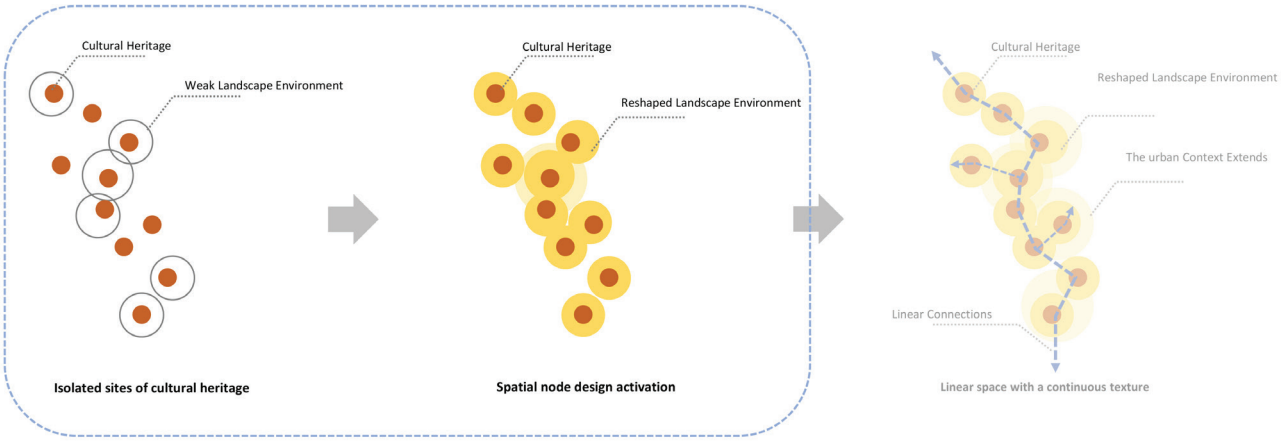


Fig. 2. From isolated cultural heritage to node activation (Figure credit: author's drawing)

the visit. Furthermore, for some important historical relics or protected sites, the signage and guidance system can be restructured, and infrastructure can be enhanced to elevate the spirit of these locations [18]. Finally, for cultural industry development spaces represented by exhibition spaces and creative commercial spaces, accessibility should be clarified to facilitate visits, thereby enhancing the diffusion of the site's cultural context and external influence.

For instance, in 1996, the Central and Western District Council of Hong Kong established the Sun Yat-sen Historical Trail, which was renovated in 2006 to coincide with the completion of the Sun Yat-sen Memorial Hall. Following characteristics of rich historical background and dense heritage resources, a route was formulated that links 15 heritage points. Collaborating with local designers, created multiple public street spaces along the route, incorporating public art themed on «ancient and modern art». The designers restructured the design language to create 16 memorial plaques along this promenade. For example, a copper installation art piece reimagines the image of martyr Yang Quyun, and a screen art piece showcases «Queen's College», presenting a temporal comparison of Sun Yat-sen's youth, the old site of the college, and the revolutionary events of a century ago, along with the developmental history and contextual characteristics of Hong Kong [9] (fig. 3).

Emphasizing the Continuity of the Texture of Spatial Interfaces:

Kevin Lynch believes «streets are the absolute dominant element in the city. They can become important iconic features through many methods» [8]. Therefore, the continuous spatial interface formed by the heritage trail and the surrounding streetscape is a concentrated presentation of the stylistic features of urban context and a unified display of spatial order. This often results in a rich and varied interface, with the most typical example being the facades along the streets within blocks. The interface constructed from building materials of different colors, textures, and volumes in cultural heritage trails contributes to an overall aesthetic. This

(a) Yang Quyun assassination sculpture *(b) The old site of the Central College* *(c) The old site of Yang Yaoji* *(d) The old Hutchison stack*

Fig. 3. Node activation using public art in Hongkong Sun Yat-sen Heritage Trail (Figure credit: https://www.discoverhongkong.cn/china/explore/culture/dr-sun-yat-sen-historical-trail.html)

visual effect and the embodiment of spatial characteristics are essential. According to the principles of perspective in the field of art, the visual focal points of different spatial interfaces are inconsistent, which can lead to varying spatial experiences [2] (fig. 4).

In selecting its historical cultural path, Boston has chosen the theme of the American Revolutionary War and named it the Freedom Trail. As an essential landing point for European immigrants and the birthplace of the American Revolutionary War, Boston is a major center of American culture. In 1958, the Boston government designed the trail using red brick paving, linking 16 historical heritage points from the Revolutionary War era. The entire path consists of a 20-centimeter wide red brick band on the ground and specially designed copper circular markers, spanning approximately 4 kilometers. These red brick routes, paired with the heritage point signage design, symbolically and metaphorically remind visitors that they are in valuable historical spaces. Moreover, visitors can follow this metaphorical signage system to sequentially visit each relevant heritage point without needing additional navigational information [11] (fig. 5).

Shaping the Continuity of Cultural Context in Space:

The influence of a single catalytic point or even a continuous catalytic line on the spatial sites of cultural heritage trails may still be limited, as it can only catalyze reactions within a localized spatial range. Therefore, creating a systemic current catalyst through multiple point-like catalytic elements is a way to enhance the catalytic reaction.

The catalytic reaction of non-material elements serves as an effective method for this approach and is a valuable complement to material-form catalysts. This can be specifically reflected in the design of block spaces, where historical cultural blocks can undergo spatial expansion at their original cultural nodes. Moreover, certain urban events can be added to these spaces to enhance the efficiency and experience of cultural space usage. For instance, organizing tourism festivals, cultural festivals, and other activities will impose new requirements on the spatial expansion and functional updates of historical cultural blocks. Corresponding arrangements of activities and scene designs should align with these needs, emphasizing the

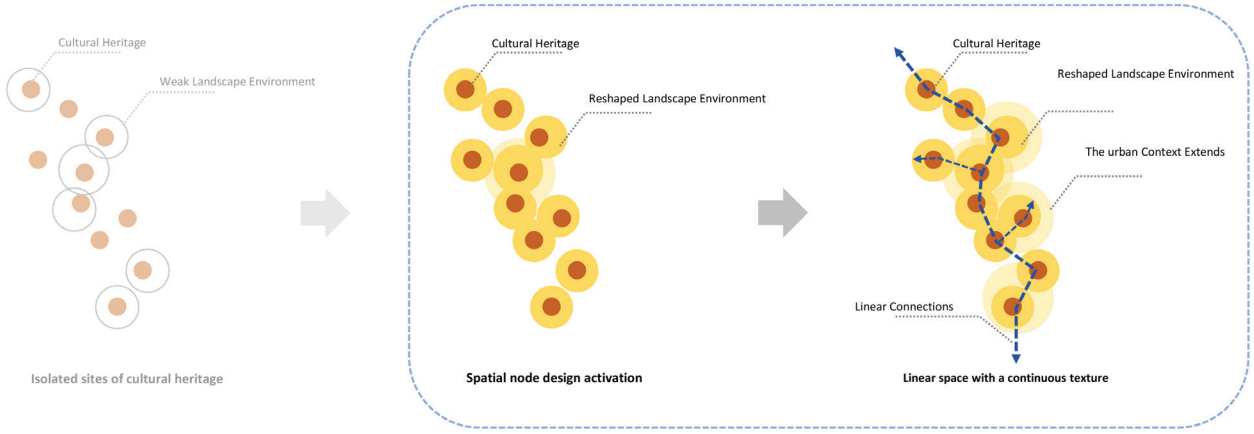


Fig. 4. From node activation to linear connection (Figure credit: author's drawing)

(a) Spatial continuous interface element: red brick

(b) A recurring sign along the trail: bronze

(c) A walking trail using red bricks to connect 16 historical sites

(d) The red element of the guide system

Fig. 5. The spatial interface texture continuity in the design of the Boston Freedom Trail. (Figure credit: https://www.sohu.com/a/125739969_571155)

preservation of cultural values and forming a linear narrative structure of cultural catalysts.

For example, in the planning and designing of the Boston Freedom Trail, the management organized various role-playing activities. Many interpreters or actors dressed in clothing from the Revolutionary War period walk along the cultural heritage path, interacting with historical sites and the public. This interactive scene increases visitor engagement and enthusiasm. These scenarios allow visitors to have an emotional experience of traveling through time, creating a design interaction between environmental space and historical time, thus revitalizing the historical heritage [4].

CONCLUSIONS

This paper analyzes the urban catalytic operation methods during the planning and design process of cultural heritage trails. It delves into various catalytic perspectives, including point-like, line-like, and plane-like catalysts. Drawing on the construction experiences of the Boston Freedom Trail and the Hong Kong Historical Trail, it summarizes and studies the methods for linking fragmented historical remnants, as well as the continuous narrative approach for heritage spaces, providing detailed analysis and conclusions. Furthermore, based on catalytic operation methods and manifestations, it extracts corresponding design steps under catalytic strategies in the design process of urban heritage trails, offering specific methods for the practical design of cultural heritage trails.

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АНОТАЦІЯ

Вань К., Шмельова-Нестеренко О. Є. Дизайн маршрутів культурної спадщини на основі теорії міського каталізатора: стратегії та підходи.

Мета. *У статті розглядаються такі проблеми, як нечітка організація простору та недостатня інтеграція з навколишніми функціями при проєктуванні стежок міської спадщини. Основна мета – дослідити впровадження широко застосовуваної теорії міського каталізатора в практику планування та дизайну стежок культурної спадщини, що забезпечить нові перспективи та методи теоретичних досліджень в цій області.*

Методологія. *Завдяки комплексному огляду літератури це дослідження аналізує тенденції розвитку стежок спадщини та принципи теорії міського каталізатора. В статті використано тематичні дослідження для визначення характеристик дизайну середовища та критичних факторів, що впливають на ефективність маршрутів спадщини через призму теорії каталізатора.*

Результати. *Отримані дані свідчать про те, що проблеми, з якими стикаються маршрути міської спадщини, можна ефективно пом'якшити шляхом прийняття стратегії просторової організації, яка переходить від точкових елементів до більш широких територій. Дослідження окреслює три ключові етапи проєктування: активація просторових вузлів, забезпечення безперервності просторових інтерфейсів і розширення міського контексту, підкріплене ретельним аналізом випадків.*

Наукова новизна*. Це дослідження вирізняється застосуванням теорії міських каталізаторів для вирішення конкретних проблем дизайну в межах стежок спадщини, ефективно узагальнюючи та формулюючи відповідні методи для практиків у цій галузі.*

Практична значущість. *Висновки, отримані в результаті цього дослідження, забезпечують теоретичну основу та чіткі вказівки для планування та проєктування майбутніх маршрутів міської спадщини, гарантуючи їх кращу інтеграцію з міським контекстом та покращення культурного досвіду для відвідувачів.*

Ключові слова: *стежка спадщини, міський каталізатор, дизайн середовища, дизайн вуличного ландшафту, культурна спадщина, міський дизайн, матеріали, кольори, міське середовище, об'єкти дизайну, вуличний простір, просторове сприйняття, громадський простір, туризм.*

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