

Transitional edges: Study on utilization of the space under urban elevated in China

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Abstract

This study aims to discuss the possibility of the leftover space under elevated roads as urban transition space and to provide design ideas in this space. A literature review is undertaken to identify the leftover space under elevated roads, basic elements and components of elevated roads, human behaviors under elevated roads, and the basic elements and functions of the transition space. Based on this, the research questions are formulated and discussed through a case study of solving the problem of the leftover space under elevated roads and successfully creating transition space. A table of projects is also compiled to provide concisely listed realistic conditions of using the space under elevated roads and to analyse the feasibility of establishing a qualified transition space. The study recognizes the feasibility of developing the leftover space under elevated roads as an urban transition space. The research results reveal that a successful transition space design under elevated roads must be based on urban planning combined with the transition principle and human behaviors. Only when these three conditions are satisfied, a successful transition space be designed. The three are the basic elements of the transition space under elevated roads. If a better transition space is expected, further considerations on the details of the space under elevated roads should be required.

Keywords

Transition space; elevated road; human behavior; remaining space.

1. Introduction

With the urban expansion, the surging traffic volume, and the accelerating urbanization, elevated roads have become an important means to address urban traffic problems. The elevated roads to urban areas have become a factor that cannot be ignored in urban space. However, these spaces are not utilized actively and are often set aside or neglected. Urban designers are aware of the problem. "Present and Futures: Architecture in Cities" was the topic of the 19th Congress of the International Union of Architects in Barcelona in 1996. As urban population density increases, we should strive to manage both public and ecological open space. And not only should we fight for space on the ground, but also underground space and space above the water. The urban space above the ground such as the elevated roads has not been fully utilized, and it is also one of spaces that we need to fight for at present.

As a part of the urban infrastructure, overpasses are not often noticed and certainly not favoured by the public. People accept overpasses simply for practical and financial reasons (Harnack and Cohler, 2011). The argument that modern urban centres were invaded by overpasses first came from the Italian and futurist sociological movements in the early 20th century. Architect Sant'Elia believes that the city in the future should have many intersections for transportation that are linked to metal walkways and fast conveyor belts. But the space along and below the overpasses affects how citizens experience the city. They cut off the connection between the urban space and the adjoining two spots, resulting in unwelcome

physical and psychological experiences of pedestrians (Trancik, 1986). For these reasons, relevant departments have tried to integrate roads into urban space to make full use of urban spaces and solving the problem of divided urban space due to elevated roads.

Based on related research and concepts of transition space, combined with the spatial characteristics and structural elements under elevated roads, this dissertation defines and evaluates the space under elevated roads in Chinese cities. Through the case study, this dissertation tries to follow the principle of transition space and provide suggestions for designers on how to use the space more actively. The dissertation offers clues on how to create an environment beneficial to mankind in the leftover space and explore the potential of combining adjacent space and functions, thus making the environment more continuity- and spatiality-oriented and creating a potential public space that can provide optimized social benefits.



Figure 1: Status of remaining space under the evaluate road. (11 ugly urban underpasses now functioning as public parks, 2021)



Figure 2.1& 2.2: Status of remaining space under the evaluate road. (Clifford, 2021)

1.1. Aim:

This dissertation aims to put forward the method of following the transition principle to solve the problem of using the leftover space under elevated roads and explore its potential to alleviate the problem of urban fragmentation.

1.2. Objective:

Define elevated roads and transition space;

Determine the information of space under elevated roads, such as structures, space properties, and user analysis;

Analyse the behaviors of people;

Determine the basic properties and functions of transition space;

Analyse and determine how to follow the transition principle to solve the problem of utilizing the leftover space under elevated roads through the case study.

2. Methodology

This dissertation adopts the methods of literature review and case study. The literature review develops an overall conceptual framework and is divided into three main parts: a) to determine the present situation and basic information of the space under elevated roads; b) to research on human behaviors according to Gehl and Gemzoe; and c) to understand the concept of transition principle. Then comes the case study, which explores three design cases of space under elevated roads that have been implemented. The cases are selected based on three kinds of possible environment with different forms of elevated roads (i.e. the leftover space under the elevated roads across commercial and service space, the leftover space under the elevated roads across urban water areas, and the leftover space under the elevated roads across park green space). Then a summary is made on the existing design methods which have positive significance to space reconstruction and the deficiencies of the existing design to shore up the weak links of the current design and reduce the elevated roads' impact on urban fragmentation.

3. Definition of research scope

3.1. Definition of elevated road:

In the Oxford Dictionary, elevated roads are 'located above ground level on an embankment or supported by columns. Reasons for elevation could be to prevent flooding or to allow passage of vehicles/pedestrians beneath.' (Gorse, Johnston and Pritchard, n.d.)

The urban motorway, which runs through or around the city centre, has become one of the most visible parts of the urban infrastructure. Infrastructure and urban development are interdependent and have always been one of the most important topics in urban research (Hauck and Kleinekort, 2011). Elevated roads include overpasses and rail transit lines. 1) Overpasses refers to the expressway built in the air in cities. This kind of structure in the air is used to reduce traffic density and improve transportation efficiency. Overpasses usually appear on original roads in the city, and sometimes they also pass through different areas with the help of rivers, creeks, or other urban lands. Overpasses are effective in addressing traffic congestion at intersections and improving traffic flow. 2) Urban rail transit lines include subways, light rails, trams, and maglev trains, and so on. Rail transit lines are built above the city ground by means of building supporters, so there is no essential difference between the spatial impact of overpasses and rail transit lines on the city.

3.2. Definition of transition space:

Anthropology authors such as Arnold von Gennep (1909/1960), Erving Goffman (2007), and Victor Turner (1974) have portrayed liminality as a transitory stage in rituals, especially in rites of Passage (Turner, 1969). It is regarded as a state of blurred boundaries. Transition space refers to the transition from one space to another and is the space between the indoor and outdoor environment as a buffer and physical connection. If the interior and exterior are two defined spaces, the other spaces in the middle are their transition spaces. It is also a natural connection between two places of different natures, and it is the combination of "semi-public space" and "semi-private space". It has the dual nature of urban space and architectural space. There are generally two ways for transition space to exist. First, the transition space is a region connecting the surrounding environment, and the typical representative is a semi-private and semi-public park that exists independently from the single building. Second, the transition space acts as the area between urban space and architectural space, namely, the grey space in architectural space (Trancik, 1986). This dissertation mainly studies the first one, i.e., transitional space as a semi-private and semi-public park connecting the surrounding environment.

The space under the elevated road discussed in this dissertation will use the definition based on definition of the National League of Cities (Godwin, 1968), the space under the elevated road discussed in this dissertation, The term 'airspace' refers to a specific, legally described area located under or above a road facility or railway track. Following this, Crisman (2009) stated that the gap caused by 'space between one thing and another' usually resulted in problematic areas without continuity in the house and social structure. Such areas are often referred to as lost Spaces. Additionally, large areas of undeveloped land become scarce, and public land or airspace provides a way for the continued development of cities along with the acceleration of urab development (Mason, 1991). Therefore, this dissertation focuses on the restoration of the urban space divided by the elevated roads by connecting such space as a transitional region to the urban plot.

4. Literature Review

This literature review discusses the basic situation of the remaining space under the elevated road, the analysis of human behavior and the basic condition of the transition space, which can be seen in Figure 3.

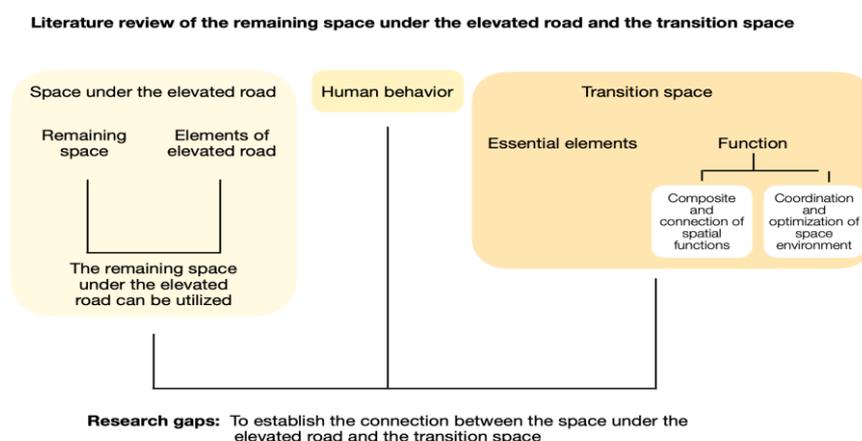


Figure 3 Literature map outlining the key themes within the literature review.

4.1. The leftover space under the elevated road:

With the acceleration of urbanization, the urban population has surged notably, with increasingly scarce urban land and serious traffic congestion. The soaring traffic demand promotes the development of urban traffic roads through the main development mode of constructing elevated roads. The main function of elevated roads is to increase the mobility of urban residents, and the existence of such urban infrastructure produces specific spaces with special spatial characteristics (Hauck and Kleinekort, 2011). At present, one of the main causes of the global landscape shift is the development of transport infrastructure (Burgi et al. 2004; Forman et al. 2003).

The impact of landscape fragmentation caused by the development of transportation infrastructure on landscape includes not only the basic components of the landscape but also the aesthetic, ecological, historical, and recreational qualities brought by transportation infrastructure (Forman et al. 2003; National Research Council 2002; Canters, 1997;). The increase of elevated roads leads to a gradual increase in undefined and unavailable spaces in the city, disrupting the landscape system, land use, and public areas of the urban space (Akinci et al. 2016). Undefined and unavailable space under motorways is often referred to as lost space (Trancik, 1986). In the original definition, 'leftover space' can be considered an 'extra area' that exists between the outer and inner layers of space (Venturi, 1977). Crisman (2009) states that the gap caused by 'space between one thing and another' usually results in problematic areas without continuity in the room and social structure. Such areas are often referred to as lost spaces. Such spaces usually refer to negative urban spaces that are underutilized or not functioning. To sum up, not all land can be reasonably planned and used in the process of urban development. In addition to the neglected leftover space under urban elevated roads, there is also an inevitable waste of space in the urban service facilities, such as the grey space around stations and the corners of buildings. The spaces along and below elevated roads also influence the way people experience the city. They belong to the undesirable landscape disconnected from the community, which cause psychological barriers and unpleasant physical experience for pedestrians (Trancik, 1986). Saouma (2008) thoroughly analyses the impact of elevated roads on urban areas and identifies six effects: (1) symbols of progress, increasing accessibility and mobility; (2) the dominant structure in the urban structure; (3) the isolated community or neighborhood, resulting in physical and mental impairment and visual intrusion; (4) undefined spaces that are often ignored and misapplied; (5) the space under the elevated structure allowed to minimize poor ventilation and natural lighting; and (6) common leftover or wasted space. Therefore, the discussion focuses on how to repair urban spaces segmented by elevated roads with such leftover spaces as transition areas to connect urban plots of land.

4.2. Elements of elevated road:

The elevated roads cannot be discussed without urban morphology and urban planning. According to Jacobs (1961) (Gorse, Johnston and Pritchard, n.d.), urban planners and architects such as Sir Patrick Geddes, Ebenezer Howard and Le Corbusier adopted land-use zoning laws in urban planning, which had a huge impact on urban transport planning in Europe, the United States, and Asia.

Three ideologies have been observed regarding the state of urban roads and their effect on urban structure. First, overpasses have a positive impact on urban spatial connectivity and continuity (Brandao and Brandao, 2017). The first generation of overpasses were constructed of steel and precast concrete without aesthetic value (Samuel, 2006). Second, urban planners utilize the concept of the automobile as part of the design concept of the title. The third ideology is reflected in the contemporary and innovative renovation of the motorways and making it more accessible to the landscape.

According to the position relationship between the elevated lines and the surrounding buildings and roads on the cross-section, its basic spatial combination modes can be divided into the following types: road centre, one side of the road, road edge, and independent existence. which can be seen in Figure 4.

The space under elevated roads is unique. Due to the functional requirements of the elevated road structure, piers and decks have unique properties. To bear a huge dynamic load, the supporting part of the pier is relatively thick and strong. To meet the requirements of the width of the driveway, the deck is designed as a wide banded deck. As a result, the volume and scale of the viaduct have a great influence on the city.

The space under elevated roads can be divided into the following four types (Shi, 2016):

Main road space: This space form is dominant. It is used to provide service for the motor traffic in the city. Because its function has been fixed, the space is not available.

Space under the ramp: The elevated road, serving as a ramp, connects to the ground, where the lower space is restricted, limiting the possibility of use.

Space generated by supporting structure: Due to the existence of structural components supporting the elevated road system, the space between these structures is relatively unavailable for cars, but this space of a large scale can be used.

The space generated by the interlacing of elevated roads: The three-dimensional underpass space intersected by two or several elevated roads is usually filled with a large green landscape at the edge of the city. In urban areas, such spaces are often at the intersection of roads. As a result, its probability of utilization is low.

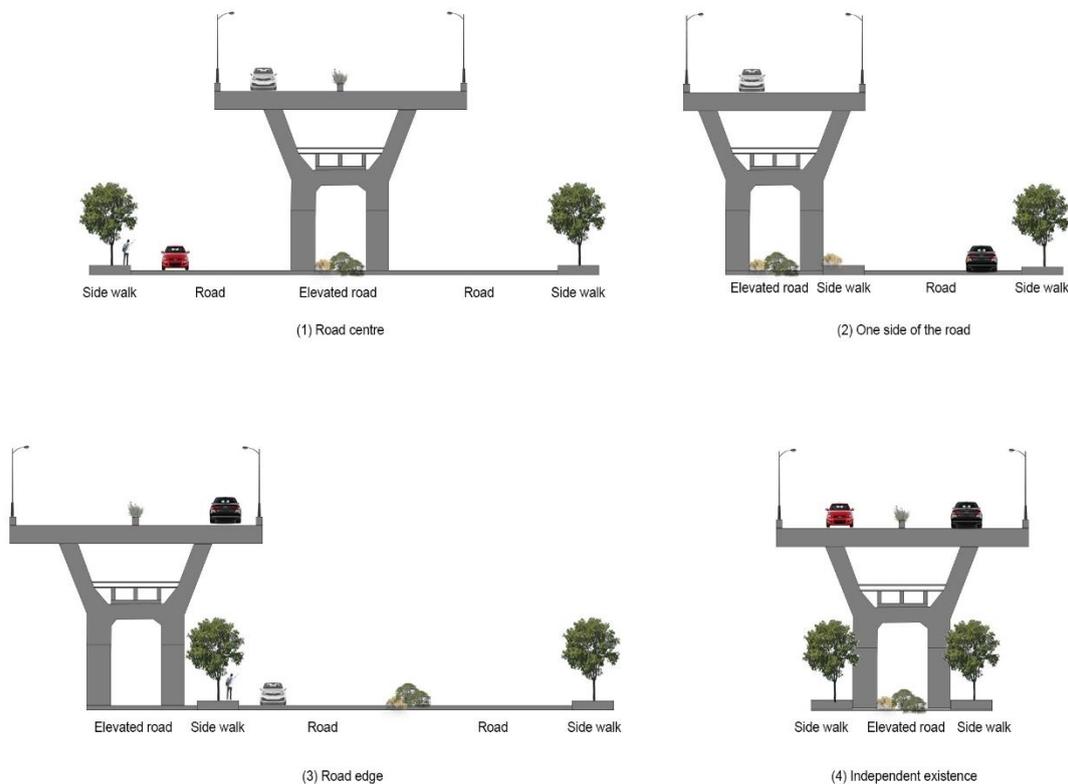


Figure 4 The combination of the elevated road and the surrounding space type.

4.3. Human behavior under the elevated road:

Urban space is inseparable from human activities. Since elevated roads are involved in the city, the activities of urban people should be correspondingly integrated into elevated roads. Urban roads are discussed from the perspective of urban morphology and urban planning. In the

traditional city, administrative and commercial buildings, and public spaces are designed in proximity with no urban roads in between. This layout promotes walking activities and reduces people's dependence on cars and motorways (Sahabuddin,2011). However, in modern urban planning, urban traffic has become an integral part of urban land use planning. If the leftover space under elevated roads is used to create transition space for human activities, it entails the research on human activities as the basis. Outdoor activities in public spaces can be classified into three types: essential activities, spontaneous activities, and social activities. Each type of activity has different requirements on the physical environment (Gehl and Gemzøe, 2004).

Essential activities can be understood as activities that carry a task and must be done. Such activities are going to work, traveling, going home, etc. These activities do not have much room for choice, but the surrounding environment has a direct impact on essential activities. The essential activities under elevated roads are mainly represented by bus and crossing waiting, which are mainly affected by the urban traffic system and have little connection with the elevated road itself. But the existing environment of the elevated road cannot provide suitable activity space.

Spontaneous activities are the opposite type of essential activities. Such activity can occur only when people have the desire to participate in the activities and the outdoor environmental conditions are suitable. The occurrence of such activities mainly depends on whether the place is attractive and whether objective conditions for spontaneous activities to occur are available. The spontaneous activities that may occur under the elevated areas include walking, doing morning exercise, resting, and playing sports. Activities such as walking, doing morning exercises, and resting often take place in areas with low traffic volume, low noise, and sufficient greenery, and other related facilities. This means that such activities take place under the elevated roads adjacent to the urban living space. However, sports and other activities require more space and can only occur in the open space under the elevated road without the obstruction from the road. The improved space under elevated roads has the potential to provide such space in the context of insufficient urban activity space.

Social activities refer to all kinds of public activities in public spaces, such as talking, playing chess, playing cards, and so on. This type of chain activity is an extension of both essential and spontaneous activities, meaning that changing the conditions for both activities can promote social activities. Social activities under the elevated road are mainly commercial activities by street vendors, which require a certain area undisturbed by other activities. At the same time, social activities require essential and spontaneous activities to provide a large number of people, so that commercial activities can be sustained.

It can be seen that the environment is closely related to human behaviors and activities. When the environmental quality cannot be guaranteed, only essential activities can occur on the site. Spontaneous activities need to be enhanced with the improvement of the environment, and social activities produced by the chain effect of essential and spontaneous activities are also greatly affected.

4.4. Essential elements of transition space:

Gray is a mixture of black and white. The result is neither black nor white, but a new and special intermediate colour (Kurokawa and Kurokawa, 1994). This concept refers to the colour on the one hand, and on the other hand, it refers to the transition between the closed space of the building and the open space outside. Kevin (1960) believes that roads, nodes, boundaries, regions, and markers can be regarded as five basic elements of a city. Combined with the theory of transition space, this dissertation takes boundaries, nodes, regions, and markers as the basic elements of transition space.

Boundaries: A boundary is a linear element dividing two fragments, it is a linear crack on a continuum (Kevin, 1960). The boundary of transition space can be classified into the physical

boundary and psychological boundary. Physical boundaries, such as walls and columns, are real and cannot be replaced at one's will. Psychological boundaries are the mental boundaries that people have different psychological feelings to the same physical boundary. The mental boundary changes as the person's perception shifts, compared with the physical boundary. According to the behavior analysis of people under elevated roads, the factors affecting the transition space are explored to reduce the impact of the boundary on people's perception and improve the utilization rate of transition space.

Nodes: Kevin (1960) believes that nodes are, to a different extent, points where people converge and concentrate. Combined with the transition space, nodes are usually represented as the interface space between the space under elevated roads and the surrounding environment, namely, the passageway, functional space, and streets under elevated roads.

Regions: Region represents different functional areas in a city. Whenever people enter a region, they can perceive its distinctively common characteristics and experience site effect. As a basic constituent element of transition space, the region refers to the urban public open space on the transition space moving line. The area can be used as a form to enrich transition space, providing a place for social activities.

Markers: In urban imagery, markers are another type of reference point, often used as a clue to identify the status and spatial structure. Among the basic elements of the transition space, markers are the reference of the transition space, which generally exist in combination with other elements. This helps people form maps and reference points in their memory and improve their sense of regional identity.

As the components of the transition space, it is necessary to arrange and combine the boundary elements of traffic, transformational node elements, public open regional elements, and identification marker elements to construct the transition space system of integrated construction.

4.5. Function of transition space:

Composite and connection of spatial functions

Transition space is a connective space with certain traversability and permeability. Transition space has the top interface, thus showing the property of interior space. However, due to the lack of a four-way test interface in various degrees, the transition space has the property of outdoor space. Therefore, the transition space can be seen as a space existing both indoors and outdoors (Arnheim, 2011). Alexander (1997) conducted a careful study of the boundary effect in public space and believes that in all these cases, the most important thing is to make the transition a real space existing between the inside and outside of the building. Therefore, due to the complexity and uncertainty of transition space, it is neither indoor nor outdoor, but a semi-public place, which can meet social needs such as gathering, leisure, and entertainment.

Coordination and optimization of the spatial environment

Human perception shifts due to spatial changes, and the change of space exerts an impact on human behaviors through human physical and psychological perception. Through the study of human perception and behaviors, Gehl (2011) concluded the law of the relationship between human sociality and space. The internal relationship makes the transition shifting from small groups and small spaces to larger ones in the space system, and gradually from private spaces to spaces with stronger publicity. Therefore, the function of transition space is not only a connection in the physical space and a carrier of spatial diversification but also an important factor affecting the environmental changes perceived by people.

4.6. Summary and research gaps:

This literature review has achieved Objective 1, 2, and 3. From the perspective of the impact of elevated roads in the city, they are incompatible with the city landscape. But through the

analysis of the space structure under the elevated road, the space can be redefined, transformed, and reused. The space under elevated roads is currently in a state of lacking content and waiting to be filled and transformed into a more substantial public area. Space and behaviors complement each other, and space without people is meaningless. But if there is no space and environment to rely on, human behavior will not occur. Therefore, it is necessary to look at the psychological reaction behavior pattern of people in the space to create the space under elevated roads with human nature. The literature review shows that urban transition space is an indispensable node in urban spatial structure. As a connective space, it has a certain degree of traversability and permeability. Its basic function is to carry the traffic flow under elevated roads and connect the space on both sides divided by the elevated road.

The connection between the space under elevated roads and the transition space principle has not yet been established. The current research on the utilization of space under elevated roads is mainly aimed at activating these leftover spaces and making them into a series of urban spaces that inject new connotations into urban daily life and emphasize social interaction. The current research ignored a series of problems of urban fragmentation caused by the emergence of elevated roads in the city, and it also neglected the correlation problem of urban space under elevated roads and the surrounding environment. Therefore, it is necessary to explore how to mitigate and reduce the impact of urban space under elevated roads on the city and identify methods to strengthen the surrounding urban space landscape continuity.

This may contribute to the rational use of the lost urban space, relieve the urban space pressure, and enhance the integrity of urban space. Therefore, the case study focuses on design projects located in the space under elevated roads that help enhance the continuity of the surrounding environment, to identify the contributing factors to spaces under elevated roads with transitional properties. This study is beneficial to landscape architects by providing them with new directions and ideas for the future design of the space under elevated roads, as well as new solutions for urban planning.

5. Case Studies

This Chapter aims to explore what design techniques can address the fragmentation of the space and the surrounding environment with the transition principle applied in the space under elevated roads through case studies. The following research questions are based on the literature review. The purpose of answering these questions is to summarize how the originally negative space can be transformed into a positive transition space through the transition principle.

5.1. Research questions:

What types of space exist under elevated roads? Do they all have the potential to be transition spaces?

Which design methods can intervene in the behavior of people in the space under elevated roads? How to lead people to generate more behaviors and activities in this space? What kind of design will promote activities in public space?

Will the urban fragmentation caused by elevated roads be improved through design? What improves the situation or alleviates the problem?

In these cases, was the space under elevated roads designed before or after elevated roads were built? Does the order in which they are built affect the use of the transition principle?

What factors can directly affect the correlation between two sides of space? Can the transition principle be an effective means of intervention?

5.2. Case studies:

The following cases are selected to explore the effective means of applying the transition principle in the space under elevated roads: A8 Motorway Park, Netherlands (the type of elevated road that spans the commercial and urban functional areas), Sky Rail Activity Park, Melbourne, Australia (the type of elevated road that spans the community), Landscape Design of Guangdong Donghao Chung Elevated Road, Guangzhou, Chinese Mainland (the type of elevated road that spans the water), and Green Corridor, Taichung, Taiwan (the type of elevated road that spans the parkland).

The case studies are selected based on the following criteria:

Different spatial forms under elevated roads.

A positive activity space created under the elevated road following renovation.

Designs exerting interference and influence on human behaviors.

Connecting the urban space divided by the elevated road.

The purpose is to explore how the space under elevated roads could be transformed in different situations to explore the reasons for and the design approach to the success of the space as a transition space.

5.2.1. Case studies 1: The Type of Elevated road that spans The commercial and urban functional areas- Dutch A8 Motorway Park

5.2.1.1 Context and theory

The literature review identifies that elevated road is one of the main causes for urban fragmentation. Therefore, this case study discusses how to mitigate the fragmentation impact of the elevated road on the surrounding environment. In addition, since there are different types of space under elevated roads, the case study also explores which form of intervention would be more effective in solving the fragmentation of functional areas.

5.2.1.2 Methods

This case is chosen because it connects the functional areas on both sides of the town, which are divided by the elevated road, through the renovation and design of the space under the elevated road. Relevant information and data from news reports, journals, and websites are used to gather evidence of effective design practices for transition spaces.

5.2.1.3 Background

This is the Dutch A8 motorway park designed by NL Architects. Koog aan de Zaan is a small village near Amsterdam along the Zaan River. In the early 1970s, a new A8 motorway was built (Dutch A8ernA Park, 2021).

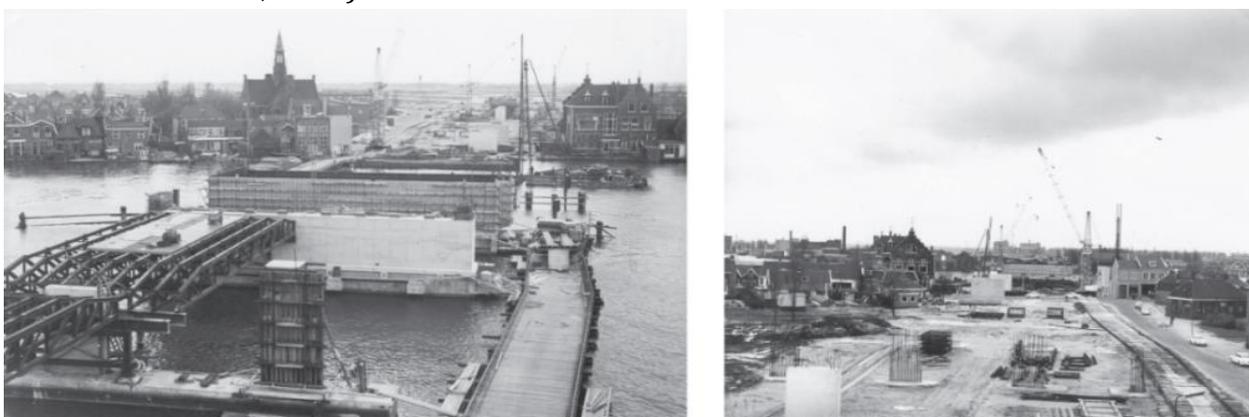


Figure 5 The situation of the Dutch A8 Motorway Park before it was redesigned. (Dutch A8ernA Park, 2021)

To cross the river, the A8 motorway, supported by pillars, cuts through the town and forcibly tears the fabric of the city. Ironically, this advance in modernization has led to a notable divide between religions and the country: on one side of the elevated motorway is a church, while on the other side once stands the town hall (A8 Expressway Park, 2021).

Therefore, the project aimed to reuse the space under the elevated road and reconnect the divided sides of the town. The local government solicited opinions and invited residents to participate in the construction of a public space called A8ernA (Dutch A8ernA Park, 2021).

The project combines parking lots, retailing (supermarkets, florists, fish shops, etc.), sports facilities (basketball courts, football fields, stages, foosball tables, etc.), sculptures, fountains, bus stops, and others. These attractive and functional spaces are now located in front of the church and serve as new gathering centres, encouraging residents and visitors to stay around. The project reconnects the two sides of the town in a new way and brings new vitality to it (Dutch A8ernA Park, 2021).



Figure 6 The current situation of the Dutch A8 Motorway Park. (Dutch A8ernA Park, 2021)

5.2.1.4 Transition Space Design

The community's wishes and suggestions were included in a document called A8 Motorway Park. Local people, ranging from residents to retailers, from youth to seniors, made suggestions that became the starting point for reconstruction. The document includes a supermarket, a florist, a seafood store, a parking lot available for 120 cars, better access to the river, a park, and a "graffiti gallery" (NL Architects, 2021).

After design under the elevated road, from the west to the east are some love seats, bowl skate parks, "ramp landscape", children's playground, breakdancing stages, foosball tables, football fields, basketball courts, parking lots, crossing, squares with roofs and supermarkets on the sides, "letter columns", florists and seafood stores, pocket fountains, another crossing, a bus stop featured by sculptures, mini-wharves, "panoramic platforms," and rivers. Beside the motorway is a small park, and the experience of greenery is enhanced by rolling hills, beside which are a "barbecue hole" and a football cage. Redundant greenery is removed from the square in front of the church, thus making it more attractive and practical. It can now provide venues for fairs and, for example, on Queen's Day, become a lively gathering place (NL Architects, 2021).

The completion of the design leads to a new view: the impressive space under the motorway is not a disaster, but an opportunity. Perhaps it is possible to carry a new urban life, shifting from a desolate parking lot to a mixed-use area, from a wasteland to a focal point, and from "city edges" to a city centre (NL Architects, 2021).

5.2.1.5 Success or failure?

This project is the renovation of the space under elevated roads after the completion of the elevated road construction, which proves that the design of the space under the elevated road does not affect the application of the transition principle after the elevated road reaches the ground. The design of the space under the elevated road has successfully overcome the urban problems of fragmentation caused by the elevated road, and the project not only connects the

church and the town hall but also provides a public centre for events for the residents of the town.

The success of this project involves people's behavior analysis discussed before as well as the application of transition space

Human behaviors: The project has taken residents' desires and suggestions into account to carry out more social activities by increasing spontaneous movements in the site. Integrating users' needs into the design can help ensure the site is attractive to its surrounding residents, which is a design idea that is effective in guiding people's behaviors and activities.

Transition space: According to the essential elements of transition space mentioned in the literature review, the design follows four elements - boundary, node, region and marker. The design attempts to soften the boundary between the church and the town hall by adding multiple nodes and functional zones. For example, the greenery is removed from the square in front of the church to make it more attractive and usable, thus achieving transition in the design of the elevated road and the church. A8 Motorway Park's advantage in applying transition lies in allowing functional urban areas, commercial space and urban rail transit to transfer the flow. In addition, the transition space enables the connection functions to reinforce and integrate with each other, which reflects that the city is moving towards intensive development and moderate growth of residential density.

The main reason for the project's success is the support from the local government, the respect for and satisfaction of local people's hope, which enriches the diversity of human behaviors. What is more, the transition aspect follows the transition principle. Based on what has been mentioned above, the design delivers results as expected.

5.2.2. Case studies 2: The Type of Elevated Road that Spans The community- Sky Rail Activity Park, Melbourne

5.2.2.1 Context and theory

The literature review identifies that the space under the elevated road is utilised to create a transitional space for human activities. Therefore, this case study explores whether intervening human behaviours through design positively affects the formation of transition space or not. The case study also discusses the relation between the "connecting corridor" and the transition principle and analyses whether the technique positively impacts the composition of the transition space.

5.2.2.2 Methods

This case is chosen because it solves urban problems characterised by fragmentation using a shared path network to renovate and design the space under the elevated road. Also, the project guides people's behaviours under the elevated road through the design, injecting vitality into the site. Relevant information and data from news and websites are collected to prove that the design approaches adopted in applying human behavioural theory in transition space are practical.

5.2.2.3 Background

To complete the most extensive railway infrastructure project in Victoria, a state in southeastern Australia, March Studio was commissioned in 2016 to launch the Underline Revitalisation project by rebuilding five stations, elevating three railway lines, demolishing nine intersections, creating twenty-two-hectares public space and redesigning it into a new urban space for the community and the road network. Now, there are many public places along the railway that enjoy a high degree of public participation. They inject vitality into the transport hub around the railway station, and the new corridor node there provides facilities for mass sports and entertainment. The space's uniqueness, vibrance and inimitableness redefine the region's social and cultural value (Sky Rail Activity Park, Melbourne, 2021).



Figure 7 The current situation of the Sky Rail Activity Park. (Sky Rail Activity Park, Melbourne, 2021)

5.2.2.4 Transition Space Design

Sky Rail Community Activity Park, built along the elevated track, is a seven-kilometre-long linear park. The main challenge of the project is to create an inclusive and attractive public space that enjoys various functions, reshaping the local community landscape with newly built infrastructures taken into consideration. Removing level crossings along the railway tracks allows previously unusable public areas to serve the community, thus creating shared paths under the railway line. Community activity centres along the routes provide sports and recreational facilities, creating a unique, vibrant and inimitable space. Spaces beneath elevated roads and railways are often neglected, so the challenge is to create activity spaces and connecting corridors, and integrate low lines with the local landscape, making it a new space for public participation and entertainment (Sky-Rail COMMUNITY NODES by March Studio, 2021).

Elevated road: Grade separation, which separates the tracks to decrease visual volume, allows light and rain to enter the centre of the linear park below, maximises surface areas exposed to sunlight, is applied to the elevated road. The concrete piers and caps are sculpted to display their structural forces while reducing visual volume (Sky Rail Activity Park, Melbourne, 2021).

Activation nodes: Many activation nodes along the railway are good at adopting graphical representations and creating a solid sense of perspective through the configuration of the space, bridge piers and rooms under the railway, thus bringing a sense of pleasure in visual effect. The road node of the central east draws on the powerful perspective created by the elevated railway to create an ample virtual game-like space so that people can see through the corridor. This design enhances the sense of security and helps suppress anti-social behaviors (Sky Rail Activity Park, Melbourne, 2021).

Colour: Colours used in the project and patterns mentioned above intend to define a local identity that expresses social and cultural values of the local community, cultivate community connections and build community pride. Besides, colours create a dynamic space and act as a catalyst to bring vitality to community activities, which is an essential part of the project design (Sky Rail Activity Park, Melbourne, 2021).

5.2.2.5 Success or failure?

The project rebuilds the elevated road and the space under the elevated road simultaneously, which proves that rebuilding them at the same time does not affect the application of the transition principle in the space. The design of the elevated road space has addressed separation caused by the elevated road and integrated "low line" into the environment, creating inestimable social value for the city. The project's success involves analysing human behaviors discussed in the literature review and applying the transition principle.

Human behaviors: This case builds a public space that enjoys a high degree of public participation by guiding human behaviors. As mentioned in the literature review, outdoor activities in public spaces can be divided into three types: essential activities, spontaneous activities, and social activities (Gehl and Gemzøe, 2004). Among them, spontaneous activities can only occur when people desire to participate, and the environment is agreeable for the

activities. The design creates activity spaces and connecting corridors under the elevated road, makes full use of the ribbon-like elevated road, builds runways, cycle tracks and paths with distinctive functions. At the same time, users are guided to the space by colour, graffiti and other designs.

Transition space: In this case, the transition space serves as the "medium" in its surroundings, as described by architect Kurokawa (1994), connection, interpenetration and continuity in space. The design of the project follows the guidance function of the transition space. It uses its component to guide people to enter one space from another. It relies on space indicators to point out directions and routes, enabling people to carry out basic activities. Therefore, the design ensures that the transition space can transit space quickly and efficiently.

The main reason for the success of the project lies in the flexible use of its component advantages. While connectivity, the essential requirement of the transition principle, is achieved, the project also follows the guidance function. Such design allows the space to provide a solid foundation for outdoor activities. Combining these two factors, the plan has improved urbanites' quality of life and aesthetics and promoted the development of surrounding areas through the principle of transition.

5.2.3. 5.2.3 The type of elevated road that spans the water-Landscape design of space under Donghaoyong elevated road

5.2.3.1 Context and theory

The literature review identifies that the spatial forms under the elevated road are mainly divided into four types, and different solutions are adopted following various forms. Therefore, this case study explores the connection between the spatial structure under a particular elevated road and the transition principle. It also discusses the design method for the space under the cross-water elevated road and analyses the impact of this spatial form on human behaviors.

5.2.3.2 Methods

The case is chosen because it has a unique space environment (cross-water space under the elevated road). The overall urban planning regards the space as a node of an open public space to design, thus improving residents' lives. Relevant information and data from news and websites are collected to prove the effectiveness of design techniques in guiding human behaviors in different transition spaces.



Figure 8 The current situation of the space under Donghaoyong elevated road.(Guangzhou's "Last" Moat, 2021)

5.2.3.3 Background

Guangzhou is home to a large number of rivers. According to statistics, there are 231 rivers in downtown areas of Guangzhou, with a total length of 913km. However, as Guangzhou continues to modernise, most of the wastewater produced by residents and enterprises near the river is directly discharged into the river. As a result, those rivers turn black and smell stinky. By September 2010, to prepare for the Asian Games in November, the city's efforts to clean the rivers begin to produce desirable effects. Donghao Chung, one of the most famous cleaned rivers, is a tributary of the Pearl River. It originates from Ganxi and Wenxi of the Baiyun Mountain and joins the Luhu Lake. After arriving at the subsurface stream at Lujing Road, it will go through Xiatang West Road to Xiaobei Road. Then it flows into an open ditch near Beixuanchang Road, goes south along the Yuexiu Road and finally merges into Pearl River. (Guangzhou's "last" moat 2021).

Many sections of Donghao Chung are under Guangzhou's elevated roads, which is precisely the uniqueness of Donghao Chung. The planning for the river will take nature, ecology, openness, convenience into consideration, and work to integrate green environment, clear water, healthy and leisure life, Guangfu culture, bridges, and distinctive city walls". The construction of culture, in particular, has changed the living conditions of residents near the elevated road (Guangzhou's "Last" Moat, 2021).

5.2.3.4 Transition Space Design

In the design of the Yuexiu Bridge, the space under the elevated road is mainly divided into two parts: the close-to-water area and the plant conservation area (Guangzhou Daily, 2021).

Close-to-water area: A multi-step waterfall is built near the Yuexiu Bridge in Donghao Chung, and close-to-water platforms are built on the bank of Donghao Chung. Consequently, The riverbank sinks by 2.7m. The height difference separates the space under the elevated road from the busy road, which will depress people even if they stay at the square that stands below the elevated road. Green plants will be planted in the middle of the staircase, and flower ponds will be built to attract people to stop at the platform. The sunlight at the Donghao Chung river and stone revetment attract many citizens to Donghao Chung to play in the water (Guangzhou Daily, 2021).

Plant conservation area: There are also many trees along the Donghao Chung elevated road, some of which have grown into towering trees. Designers have taken measures to protect them, which also offers people a strong sense of participation. Most importantly, arbors make the climate more agreeable near the elevated road, blocks much noise, and provides a pleasant place for residents to live a laid-back lifestyle. (Guangzhou Daily, 2021).

5.2.3.5 Evidence of transition space benefits

According to the report, the waterfront of rebuilt Donghao Chung is trendy among nearby residents and visitors. (Changes at Donghaoyong, 2021).

"Donghao Chung was so dirty and stinky that no one wanted to stay around. We have witnessed the changes here. Now, we do morning exercises and sit on the bench here to idle away time every morning. It is like a park to us. (Changes at Donghaoyong, 2021)"

"Donghao Chung was filthy and smelly, and people had to hold their noses when walking by. After being renovated by the governments at the municipal and prefectural level, it becomes a beautiful place as the governments attach great importance to ecological conservation. Now the neighborhood regards it as a park and often takes a walk there. (Changes at Donghaoyong, 2021)"

"Before Donghao Chung was renovated, I wanted to move out several times. I want to move away, but my work made me live here. Now, I do not want to leave anymore. Every day, I will open a window to enjoy the beautiful environment there. (Changes at Donghaoyong, 2021)"

5.2.3.6 Success or failure?

This project renovates the space under the elevated road. The project's success demonstrates that, even under particular circumstances, the transition principle is still applicable to space under the elevated road. It is worth noting that the project is initially designed as a river water treatment project that improves the surrounding environment rather than a park renovation project. The space is a node in the urban planning and is designed as a close-to-water and recreational zone. Now the residents nearby enjoy this space that attracts a large number of people to visit. This proves that the project has created transition space from the perspective of urban planning.

Human behaviors: The success of this case in studying human behaviors lies in providing a venue for spontaneous activities. As mentioned above, the influencing factors of spontaneous activities under the elevated road mainly depend on environmental factors such as traffic volume, noise and greening (Gehl and Gemzøe, 2004). The project provides a sound environment for spontaneous activities by building close-to-water platforms and plant conservation areas, laying a solid foundation for the project's success.

Transition space: The application of the transition principle succeeds because the space is designed as a link in urban planning. The whole planning and design revolve around the governance of a river in the city. At the same time, the ecological environment near the river is conserved, and a historical corridor, the Donghao Chung Museum and other functional areas are built, which ensures the connectivity of the space. It can be seen from the design results that the space satisfies the four essential elements of the transition space - boundary, node, region, and marker. It also offers connectivity, dynamics and spatial experiences. By arranging and combining these elements, the project successfully constructs an integrated transition space.

Based on these factors, it is easy to see that the project succeeds because it adopts a micro perspective and ensures the connectivity and spatial experience, which enables the connection functions to reinforce and integrate with each other and demonstrates that the city is moving towards intensive development and moderate growth of residential density. In a nutshell, the project is a testament to creating a transition space from the planning perspective.

5.2.4. Case studies 4: The type of elevated road that spans the parkland- Green Corridor, Taichung, Taiwan

5.2.4.1 Context and theory

The literature review suggests that the transition space under the elevated road positively impacts urban fragmentation. Therefore, this case study explores how the leftover space under the elevated road can affect city fragmentation through the transition principle.

5.2.4.2 Methods

The case is chosen because it shows how the space under the elevated road can solve urban fragmentation and as a case for a new transportation system. In this context, the park connects fragmented spaces in the city centre. Relevant information and data from news and websites are collected to prove the effectiveness of design techniques in guiding human behaviors in different transition spaces.

5.2.4.3 Background

Taichung has an old 1.7km-long railway line that runs through the city centre. It has boosted Taichung's development. The railway has a long history, but railway facilities have gone out of time in urban development. Therefore, in 2017, Taichung City Government commissioned Mecanoo and S. Atelier, the ARIA Architect Planners design team, to renovate the railway (Interpretation of the plan | Taichung green corridor, 2021).

The design concept proposed by the team is featured by sustainable living, history, and culture of sustainability. It is hoped that the railway line is reused to connect different parts of the city sustainably, thus creating a green and biodiversity corridor and bike and pedestrian lanes to serve the community better. The design team added various sustainable planning and design

elements to the linear site, including urban renewal, public participation, historical and cultural preservation, green spaces, water resources, and loop routes for pedestrians and cyclists (Interpretation of the plan | Taichung green corridor, 2021).



Figure 9.1 The masterplan of Taichung Green Corridor.



Figure 9.2 The current situation of the Taichung Green Corridor.

(Interpretation of the plan | Taichung green corridor, 2021)

5.2.4.4 Transition Space Design

Inspiration: To preserve the area's heritage, the project is set with a consistent and recognisable theme. Under the theme, the new sustainable circulation system layout relies on the connecting patterns of the railway lines (Taichung Green Corridor, Taichung, Taiwan by Mecanoo Architecten, 2021).

A Linear Park in the City Centre: Based on the visual expression of the railway infrastructure, the route divides the existing and planning functions. Therefore, the scheme defines the linear park in the city centre and the green corridor as a public park that connects fragmented spaces in the city centre. It helps conserve the area's flora and fauna, improve connections between pedestrians and cyclists, and integrate existing and new functions into a consistent linear park (Taichung Green Corridor, Taichung, Taiwan by Mecanoo Architecten, 2021).

A destination for all: The green corridor becomes one of the citizen's destinations, attracting people to explore and enjoy the greenery there. In addition, based on the embankment's inherent characteristics, designers have built a series of places for recreational activities such as a herb garden, construction facilities, grandstands, a sports field, an observation deck, and a water park. All the functional spaces enable local and Taichung residents to efficiently and practically use the public space. By doing so, the urban infrastructure can be improved. (Taichung Green Corridor, Taichung, Taiwan by Mecanoo Architecten, 2021).



Figure 10 The current situation of the Taichung Green Corridor. (Interpretation of the plan | Taichung green corridor, 2021)

5.2.4.5 Success or failure?

The project renovates the space under the elevated road. The project's success demonstrates that the transition space under the elevated road can help solve urban problems characterised by fragmentation. Based on the old railway system, the project transforms the leftover railway space into a link and creates a green corridor in the city centre. The success of this project demonstrates the importance and influence of transition space for the city.

Human behaviors: According to the discussions about human behaviors in the literature review, the primary purpose of using the leftover space under the elevated road is to create a more pleasant place for human activities. The project, by renovating the environment, can motivate people to engage in spontaneous activities. At the same time, a better environment sees a chain of essential activities and spontaneous activities in the space, also known as social activities. Multiple activities there also attribute to the successful renovation of the site as a transition space.

Transition space: Transition space is produced when two or more objects with different properties connect, serving as the "medium". The project creates the transition space by connecting the different parts of the city through green corridors and sustainably reusing the railway. The space is a place full of human emotions and wills. It is one of the two types of transitional spaces mentioned in the paragraph above. As an area that connects the surrounding environment, it is a semi-private and semi-public park that does not belong to any building. (Trancik, 1986).

It can be seen from this case that to solve urban fragmentation in the space under the elevated road, the transition principle and human behavior must complement each other. The main reason for the project's success lies in encouraging people to carry out more activities while connecting with the surrounding environment.

5.3. Project examples

Case projects are collected to help apply transition principles in spaces under the elevated road in different environments, thereby addressing urban fragmentation.

Table 5.1: Project examples which show the remaining space renovation under the elevated road.

Project	Environmental characteristics	Elevated road type	Space type	Transition space	Human behavior	Source

Dutch A8 motorway park	Close to public services	The type of elevated road that spans the commercial and urban functional areas	Development of public space	Successfully connecting the spaces on both sides of the elevated road	social activities	(Dutch A8ernA Park, 2021)
Sky Rail Activity Park, Melbourne	Close to residential area	The type of elevated road that spans the community	Development of public space	Successfully connected the active area around the elevated road	spontaneous activities	(Sky Rail Activity Park, Melbourne, 2021)
Landscape design of space under Donghaoyong elevated road	Close to urban traffic	The type of elevated road that spans the water	Development of city park	Successfully connected the active area around the elevated road	spontaneous activities	(Guangzhou's "Last" Moat, 2021)
Green Corridor, Taichung, Taiwan	Close to urban rail transit	The type of elevated road that spans the parkland	Development of green corridor	Successful connection to the area around the city	spontaneous activities	(Interpretation of the plan Taichung green corridor, 2021)
Under nakamiguro Elevated In Tokyo	Close to urban traffic	The type of elevated road that spans the commercial area	Development of commercial area	-	social activities	(Below the Nakamura Heiroku Viaduct in Tokyo, 2021)
Platform Park by Terremoto, Los Angeles	Close to commercial area	The type of elevated road that spans the green area	Development of public space / commercial area	-	social activities	(Platform Park by Terremoto, 2021)
Rainbow Channel in Jindi Green World community, Shanghai	Close to urban traffic	The type of elevated road that spans the green area	Development of green corridor	Successfully connected the active area around the elevated road	spontaneous activities	(Rainbow Channel in Jindi Green World community, China by Antao AHA Group, 2021)

Viaduct landscape planning, Sao Paulo, Brazil	Close to urban traffic	The type of elevated road that spans the traffic	Development of public space	Successful connection to the area around the city	social activities	(Triptyque revitalizes 3km of urban Marquise in São Paulo, 2021)
Barcelona rail Garden	Close to residential area	The type of elevated road that spans the community	Development of city park	Successfully connecting the spaces on both sides of the elevated road	spontaneous activities	(Barcelona rail Garden / Sergi Godia + Ana Molino architects, 2021)

Table 5.2: Supplementary notes to Table 5.1.

Project	Detail	Source
Under nakamiguro Elevated In Tokyo	<p>Tokyo, Japan 2016</p> <p>Aim: Improve the quality of public space under elevated urban transportation.</p> <p>The design concept is "Roof Sharing". Under the railway elevated road, various types of shops are opened to promote the interaction between the interior and exterior space. The negative influence brought by the oppression of the space under the viaduct is eliminated through the lighting design, and the space with high sense is formed through clever design.</p>	(Below the Nakamura Heiroku Viaduct in Tokyo, 2021)
Platform Park by Terremoto, Los Angeles	<p>Los Angeles, America</p> <p>Aim: A simple platform park is created under the elevated railway tracks -- a true urban public space.</p> <p>The design team reduced the stylized set space, through different plants to limited space, to build a series of different environment atmosphere. People stop and hang out in this shared space like a city square. Wooden platforms are stacked to form a resting space, and tree trunks are polished into seats; Stalls sell snacks and people are having a good time in small groups.</p>	(Platform Park by Terremoto, 2021)

<p>Rainbow Channel in Jindi Green World community, Shanghai</p>	<p>Shanghai, China 2018</p> <p>Aim: Because of the social status quo of low trust and low connection between people, the design team attempted to inject colour into urban public space and remove loneliness.</p> <p>The 64 columns follow the sequence of zigzagging roads between the bridge holes to create a colourful gradient, which makes a unique landscape of the home road connecting golden Grove World Community and Nanxiang Subway station.</p>	<p>(Rainbow Channel in Jindi Green World community, China by Antao AHA Group, 2021)</p>
<p>Viaduct landscape planning, Sao Paulo, Brazil</p>	<p>Sao Paulo, Brazil</p> <p>Aim: The design brings a pleasant vitality to the 3 km long area.</p> <p>Design robust, light-resistant, low-maintenance tropical plant varieties to optimize the environment and reduce carbon dioxide pollution. The solution is to place plants under, on, and on the sides and undersides of the viaduct using rainwater collected by a newly designed rainwater harvesting system. In addition, the landscape architect also placed green service kiosks in popular areas to provide various functions of culture, catering, shops and other services for the citizens.</p>	<p>(Triptyque revitalizes 3km of urban Marquise in São Paulo, 2021)</p>
<p>Barcelona rail Garden</p>	<p>Sants, Barcelona 2014</p> <p>Aim: This is the government's urban renewal plan for this rail corridor area. In the future, the green belt will continue to extend to the surrounding Hospitalet, Esplugues and Cornellà, and eventually form a green corridor with a total length of 5 km.</p> <p>Two east-west paths connect small gardens with different functions and shapes. The north path is shaded and cool, while the south path is bathed in sunshine and warm and bright all year-round. Between the two roads, dense vegetation separates people from the noisy urban environment, creating a natural jungle in the heart of the city.</p>	<p>(Barcelona rail Garden / Sergi Godia + Ana Molino architects, 2021)</p>

Table 5.1 shows the original situation and renovation of four projects of different sizes in case studies. Conditions include environmental characteristics, the type of elevated road and space under the elevated road, improvement of the environment brought by the transition space and the type of human behaviors after renovation. These categories are following the literature review. The environmental features include spaces close to businesses, cities, public transport and stretch across green spaces and waters in urban areas. These projects are chosen because there are enough publicly available material to check the renovation of the space under the elevated road. In addition, they can mirror the renovation of the space under the elevated road and show the current situation of the space.

There are some common themes in this table:

Almost all projects act as transitional spaces in urban areas, connecting the surrounding environment and enabling people to behave differently.

Generally, renovating the space where the surrounding environment is mainly used for commercial and functional purposes as a transition space is less influential on its surroundings.

The surrounding environment and the type of space under the elevated road directly influence the improvement of the transition space.

6. Discussion

Four projects in the case study are identified as successful renovation of the space under the elevated road. The results show that they have improved the accessibility to the surrounding environment, encouraged more types of human behavior, better utilised the space, and to a certain extent, helped address the problem featured by urban fragmentation as a transition space. This is an opportunity for the city to reuse leftover urban space and create new use-values. As a result, renovation of the space under the elevated road should be supported.

The design of the A8 motorway park reconnects the two sides of the city and reuses the leftover space under the elevated road. The design focuses on connecting the surrounding environment and meeting the needs of the surrounding residents. According to the literature review, the two things take the transition principle and human behavior into account. After meeting the needs of residents, many users can undoubtedly be attracted to the site, thus increasing different types of human behaviors. New green corridors, bicycle paths, and sidewalks are built at the Taichung Green Corridor to connect different parts of the city. It can be seen that to renovate the abandoned space as the transition space, the surrounding environment and the city's current situation should be taken into consideration in the early stage. Then is it correct to say that transition space can be created through urban planning?

The renovation of the space under the elevated road is like acupuncture to urban planning, which means carrying out the small-scale renovation in the city. It focuses on a particular space and carries out small-scale renovation, thus changing the surrounding environment, injecting vitality to the city and changing the city landscape. (Lerner, 2014). However, "the acupuncture principle" does not work alone. Instead, it needs to interact and overlap with other principles. Use rose as a metaphor. If a leaf of a rose stands for acupuncture principles and other principles, only all principles interacted with each other can we get a beautiful rose. (Hoogduyn, 2014). It can be seen from the "acupuncture" theory that the renovation of the space under the elevated road must be carried out based on urban planning, which means the urban planning underpins the successful renovation of the space under the elevated road.

Although there are many successful renovation cases of the space under the elevated road, not all can serve as the transition space. Sometimes, the space under the elevated road is designed as an independent space, such as the Nakameguro Viaduct project in Tokyo, which won the Good Design Award in Japan in 2017. The project uses the 700m-long open space under the East-Ku-East crossing and Hibiya line to open 30 shops. It brings popular things here, thus injecting vitality into the space (Below the Nakamura Heiroku Viaduct in Tokyo, 2021). According to the current information, this space is undoubtedly a successful case for the renovation of the space under the viaduct. Still, for the surrounding environment, generally speaking, it performs poorly in transition. According to the analysis of existing data, the project mainly focuses on the renovation of the space under the elevated road. It fails to consider an overall picture and apply the transition principle. Undeniably, more people bring vitality to the surrounding environment. Nevertheless, the injection of vitality does not come from the connection between the case and the transition space. It is the positive development of the space that drives the surrounding economy and brings vitality. It can be concluded that the

space under the elevated road can be created when the design considers urban planning and human behaviors. Still, it cannot become a qualified transition space as it fails to apply transition principles.



Figure 11 The current situation of the Under nakameguro Elevated In Tokyo. (Detailed explanation of Tokyo Nakameguro Elevated, 2021)

Looking at the literature review, case studies and Table 2.1 altogether, it can be seen that the spatial design under the elevated road is inextricably linked with urban planning, and respect for urban development and planning is the key to successful design and sustainable development. However, as can be seen from the project under Nakameguro Elevated Road In Tokyo, human behaviors have no direct bearing on the success of transition space. Diverse human behaviors are not a decisive factor in designing transition space, but space without these types of behaviors cannot be seen as successful. Therefore, a successful transition space under the elevated road can only be designed based on urban planning, with the transition principle and human behaviors concerned. The space can be activated to connect the surrounding environment. Urban planning, transition principles and human behaviors are mutually reinforcing. Only when these three conditions are met can a successful transition space be designed.

In addition to the three conditions, the type of the elevated road and the lower space should also be considered, which means more demanding design conditions. It is clear that a successful transition space under the elevated road, a combination of strong government support (providing relevant information and support for urban planning) and community involvement are needed. After understanding the urban planning and development objectives and investigating the community needs, the project can be started according to the actual situation. The design follows the transition principle with the consideration of human behaviors. This helps activate the remaining urban space and solve various problems caused by urban fragmentation.

7. Conclusion

This study shows that the space under the elevated road can become a transitional space and connect with the surrounding urban environment. A particular type of leftover space under the elevated road is hard to develop in urban open construction. This underutilised urban space plays an essential role in addressing urban fragmentation and injecting new vitality into the region as urban development becomes more saturated in the future.

According to this study, a successful transition space under the elevated road must involve urban planning, transition principles, and human behaviors. By understanding the urban planning of the design area, the empty space is identified and then filled in with the remaining space. This meets the behavioral needs of people, inject vitality into the site and activate the

surrounding environment. Finally, the transition principle theory is used in the design to achieve connectivity and provide guidance and spatial experiences and other characteristics. By doing so, the space can be better matched with the surrounding environment. Meeting these three elements is the key to the successful design of the transitional space under the elevated road, making most of the remaining space, and ultimately vitalising the city, improving the cityscape and renewing it. Now more people are paying attention to the remaining urban space. Countless underutilised spaces remained to be activated. The development of these spaces receives more support and help. Because of this, further investigation is needed on the development potential of the remaining space. This study focuses on the feasibility and design of the space under the elevated road as a transition space, showing the space's development potential. Future research should demonstrate the various conditions and objective factors influencing the space's role as a transitional space. At the same time, more detailed types of viaduct space design methods should be created, and design ideas creating the highest practical value developed.

The reuse of urban leftover space is bound to achieve sustainable urban development and delicate management effectively. The use of leftover space should not be only applied to space under the elevated roads. In the future, research and the design should focus on more types of leftover space, and work to transform negative spaces into positive spaces. Urban development does not entail sprawling. Instead, it is a breakthrough to unleash the potential of every inch of land and make full use of the surplus value of each plot.

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