RESEARCH ON REGENERATION STRATEGIES OF OLD URBAN AREAS FROM THE PERSPECTIVE OF RESILIENCE: TAKE ERQI SQUARE IN DALIAN, CHINA AS AN EXAMPLE (1078)

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Abstract. The regeneration of old urban areas is faced with various problems such as low spatial and environmental quality, functional decline and inadequate ability to cope with emergencies, and weak resilience, but the existing regeneration strategies lack attention to resilience. This paper aims to explore the regeneration strategy of old urban areas from the perspective of resilience, clarifies the connotation of resilience in the regeneration of old urban areas, and constructs a resilience analysis framework comprising four dimensions, including economic, engineering, environmental and social dimensions. The study proposes a regeneration path that integrates the concept of resilience into the whole process, and proposes a regeneration strategy for the old areas from four aspects, including production, living, ecology and governance, in order to improve the ability of the old areas to cope with risks.

Keywords: urban resilience, old urban areas, risk response, urban regeneration

1. Introduction

In recent years, the frequency of various risks and disturbances is increasing. Cities are not only facing sudden acute shocks such as natural disasters and public health crises, but also facing chronic pressures such as aging infrastructure, low efficiency of public transport, and declining social cohesion. These two kinds of risks have brought great challenges to urban development from different perspectives. As an important part of urban land stock, the old area often weakens with the development of the city, and often faces many problems such as imperfect infrastructure, lack of public services, and imperfect governance system. Therefore, compared with the new area in the city, the old area has a weaker ability to resist risks, and it is difficult to effectively respond to risks when they come. As a result, the operation of the area may be impeded and the daily life of residents in the area may be greatly affected.

In many important development strategies, China has clearly proposed that the functions of existing areas such as old residential areas, old factories and old urban villages should be upgraded. The upgrading of these old areas should not only be limited to the improvement of existing functions within the area, but also be integrated with the concept of resilience, so that they can resist external risks and operate stably when risks come. The study combed the relevant studies on resilience, clarified the connotation of the regeneration of old urban areas from the perspective of resilience, constructed the framework and content of the regeneration of old urban areas from the perspective of resilience, expected to expand the connotation of the resilience perspective from the level of the regeneration of old urban areas, and put forward suggestions for the integration of the concept of resilience into the regeneration.

The first section introduces the background of the study and outlines the significance and purpose of the research. Section 2 provides an overview of the research process of resilience and its development in the field of urban studies and related definitions, introduces the international and Chinese research on old urban areas and defines the connotation of old urban areas regeneration under the resilience perspective studied in this paper. Section 3 presents the overall process of proposing a regeneration strategy for old urban areas from a resilience perspective, the methods of integrating resilience at different stages and the reasons for adopting each specific tool. Section four uses Erqi Square in Dalian as a practical case study to explore the application of the research framework for the regeneration of old urban areas from a resilience perspective in practice, and proposes specific regeneration measures for the problems and underlying conditions of the Erqi Square area in Dalian. Section five provides a further discussion on the integration of resilience into the regeneration of old urban areas. Section six concludes the study.

2.Literature review

2.1 Origin and development of toughness

The word ‘resilience’ is derived from the Latin word ‘resilio’, meaning ‘to return to a pristine state’. Later, it evolved into the modern English word ‘resile’ and is still used today; Holling(1973) and his research put forward the concept of ecosystem resilience, focusing on the balance of ecosystems; with the increase of risks faced by cities and the adaptability of resilience and urban systems gradually emerged, the concept of urban resilience began to be studied The concept of urban resilience has been studied, and different scholars have defined and interpreted the concept from different perspectives, and gradually developed a definition of resilient cities. Related studies such as Sara Meerow et al. (2016)define urban resilience as the ability of an urban system and all its

inter-temporal socio-ecological and socio-technical component networks to maintain or rapidly restore expected functions, adapt to change and rapidly transform systems that limit current or future adaptive capacity when disturbed. Chen et al.(2017) summarise the basic framework of a resilient city into four aspects: economic, engineering, environmental and social. The resilient city includes the ability of the urban system to adjust itself and resist external blows and the ability of the urban system to turn opportunities into advantages. Qiu (2018) classifies urban resilience into three levels: structural resilience, process resilience and system resilience, structural resilience includes technical resilience, economic resilience, social resilience and government resilience, which refer to the ability of infrastructure to cope with urban disasters, economic structure to resist financial drastic changes, social people to face major events, and government departments to maintain stability and stabilize people's hearts. Meng et al.(2022) study from the perspective of urban resilience practices, arguing that the resilient city as a whole consists of three components: resilient production, resilient living and resilient ecology.

In general, although some of the angles and dimensions are different in the analysis, these related studies express the meaning that urban resilience is the ability of cities to react to and adapt to disturbances and restore stability when they are exposed to risks or disturbances (including physical damage, economic disruption, etc.), and split the resilience construct into multiple dimensions. Subsequent researchers have built on the foundational consensus to focus on both resilience building and sustainable development to ensure the stable operation and dynamic optimisation of urban systems.

2.2. Definition of old areas and related studies

Research on old areas has focused on the redevelopment and regeneration of areas. Based on the research of Wang et al.(2022), there is no clear definition of ‘old areas’ in international studies, but the research objects include old down town areas and old residential areas. International research on old areas and related areas is often combined with capital intervention and government management, and a more comprehensive regeneration system has been built through the study of the transformation modes of different types of areas and the regeneration process carried out by various departments and regeneration bodies. Existing Chinese studies on the regeneration and transformation of old areas and areas have focused on transformation models, transformation implementation paths and outcomes, as well as governance for old communities, but the part that has formed a consensus lacks research on the resilience of old areas.

In recent years, Chinese research on old areas and communities from the perspective of resilience has mainly focused on the level of public participation and the resilience of

governance capacity. Many articles apply the concept of resilience in the study of area regeneration, but only superficially describe resilience in the definition of the concept, and do not integrate the definition of resilience with the actual situation and the characteristics and connotations of resilience in the subsequent analysis and strategy recommendation process. Some articles also assess the resilience of old areas, but only propose assessment systems and methods without subsequent case studies.

This paper argues that an old urban area is one that has been built earlier in the urban development process, has a dilapidated physical environment, has a high vacancy rate of shops, and has infrastructure support that cannot meet the current living needs of the area's residents. It often includes one or more of the old residential areas, old factories and old urban villages. In this paper, we consider the old area to include not only residential areas, but also related urban public services and infrastructures.

2.3 The connotations of regeneration in old areas through the lens of resilience

This paper argues that to build a framework for the regeneration of old areas from a resilience perspective, it is necessary to integrate the concept of resilience into the whole process of regeneration, while considering the response to different stages of resilience in the regeneration of different systems. Therefore, in the regeneration of old areas from a resilience perspective, it is necessary to consider old areas as a collection of multiple complex systems, and to integrate the concept of resilience into the regeneration of systems with different dimensions and functions. Old areas should have the ability to resist, absorb and quickly restore stable operation in different dimensions after regeneration. It also should be able to meet the needs for stable operation and continuous optimisation of different systems while resisting different risks and disturbances.

3. Methodology

In order to propose a practical regeneration strategy for old areas, the study proposes a regeneration path based on the concept of resilience. The study also attempts to present detailed methods for incorporating resilience at different stages and the reasons for adopting each specific means.

3.1 Construction of regeneration path covered by the whole process of resilience concept

The regeneration phase of an old area is often divided into an analysis of the current situation of the area, the search for a regenerable site and the proposal of a specific regeneration strategy that combines these two aspects. To build a framework for regeneration of old areas from a resilience perspective, it is necessary to integrate the

concept of resilience into the whole process of regeneration, and to consider the response to different stages of resilience in different systems of regeneration. The regeneration path is summarised into a three-stage process: exploring the problems of old areas - the search for regeneration space - proposal for a regeneration strategy that incorporates the concept of resilience (figure.1).

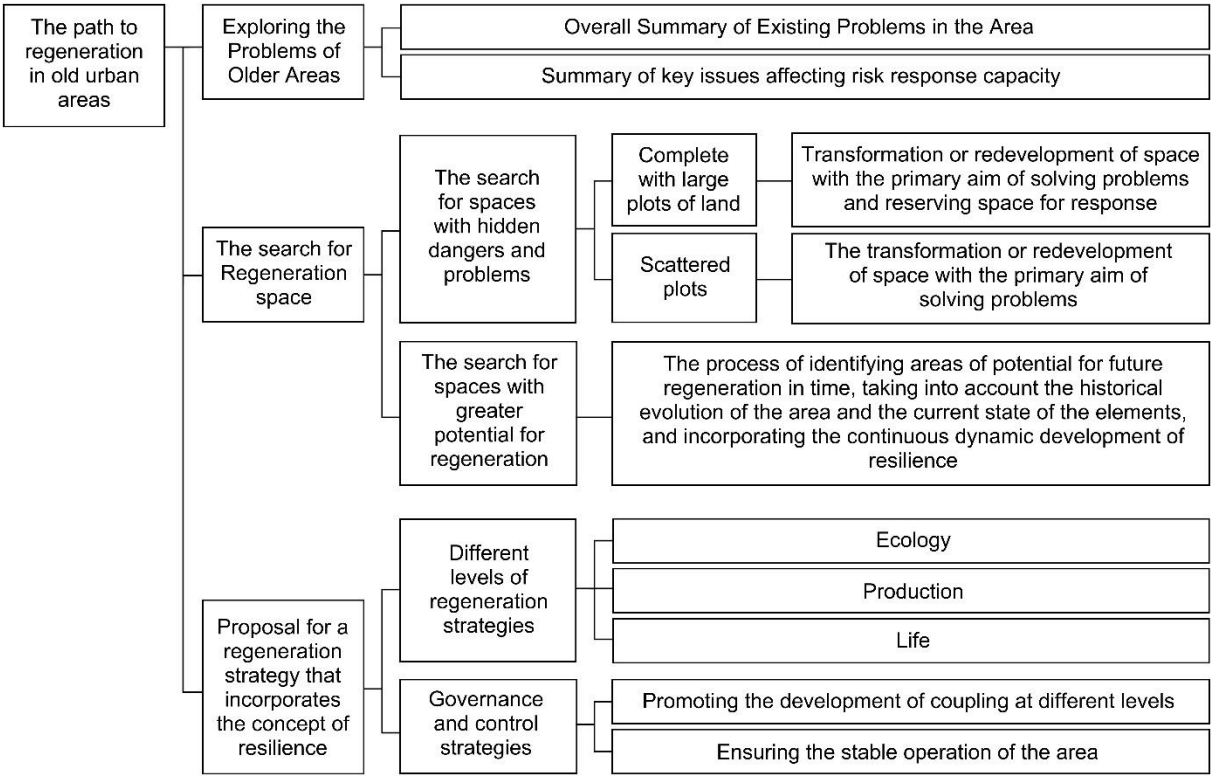

Figure 1. A three-stage regeneration path incorporating the concept of resilience

In the current situation analysis stage, while sorting out the existing problems in the area, we should focus on analyzing the key problems that lead to the poor ability of the area to deal with risks in combination with the needs of the resilience concept. In the process of solving the overall problem, we should focus on analyzing the causes of the key problems, which will support the proposal of the follow-up regenerate strategy.

In the search phase for regenerable plots, it is necessary to find spaces with larger problems and those with greater potential for regeneration. The main reason for this step is the current high density of construction in the city and the lack of space in the old areas of the city. On the one hand, the high density of construction makes it difficult to evacuate people in time in the event of a disaster, and on the other hand, it is difficult to take isolation measures in the event of a public health crisis, either of which is detrimental to the stable operation of the area. Therefore, it is necessary to identify

areas that can be regenerated on a large scale or adapted on a small scale for the construction of disaster prevention or evacuation spaces by sorting out the current spatial elements and sites. The integration of the concept of resilience in this phase of site identification means that, in addition to identifying the physical and spatial elements that are in a state of disrepair and can be demolished or rehabilitated from a qualitative point of view, it is also necessary to consider spaces that are likely to be affected by disasters and those that will be disturbed by other urban influences, such as the possible construction of future large-scale projects. It is in order to provide a comprehensive consideration of the spaces that can be used and are proposed for conversion.

Furthermore, the identification of renewable land in the region cannot only identify renewable land at a certain point in time, but rather focus on possible future areas of regeneration potential when analysing the current situation. The delineation of possible regeneration potential areas should take into account the possibility of regeneration evolution and development over different periods of time, thus delineating time-phased potential areas that will inform the future renewal of the area during the evolutionary process.

The path of regeneration can be constructed after the analysis of current problems and the excavation of regenerable potential land. In general, regeneration tends to focus on the optimisation and improvement of different aspects and dimensions, or on problem solving. Thereafter, possible regeneration strategies are often proposed for multi-level spaces and systems such as ecology, production and living. In addition, incorporating the concept of resilience into the construction of regeneration paths requires integrating different dimensions of resilience thinking into the regeneration systems at different levels. At the same time, consider how to make the system resilient in the regenerate path. In previous studies, the characteristics of toughness generally include robustness, redundancy, rapidity and resourcefulness, as well as the frequently mentioned ‘4R’ characteristics. In addition, it also includes flexibility, prevention and other characteristics. Looking at the regeneration of the old areas from the perspective of resilience, we need to consider responding to these characteristics by means of regeneration in the process of regeneration.

3.2 Regenerated content integrating multi-dimensional resilience thinking

In the process of regeneration, we often propose and build regenerate strategies and regenerate paths for different systems and dimensions contained in the area, and propose corresponding governance suggestions for the future development of the area and the aspects used to support the implementation of regenerate strategies. To regenerate a region from the perspective of resilience, it is necessary to consider how to make the complex system of the region have various characteristics of resilience through

regeneration in the process of regeneration different dimensional systems. The research believes that the regeneration content of multi-dimensional resilience thinking needs to consider four aspects, including production, life, ecology and governance, and incorporate resilience of different functional dimensions in the process, and develop the regeneration goals, as shown in Table 1.

Table.1. Regenerated contents and target framework

Regenerate content	Functional dimension	Regeneration goal - benefit improvement	Corresponding toughness characteristics
ecology	Environmental dimension	Through regeneration creates a zone with the capacity to absorb the effects of natural disasters and maintain the normal functioning of the zone's systems under the impact.	Robustness and adaptability
production	Economic dimension	Through regeneration creates an area capable of resisting external economic turbulence	Robustness and redundancy
life	Engineering dimension	Through regeneration creates a area that can meet the needs of residents in the area to use various infrastructures under different risks and disturbances, and constantly adapt to the needs of residents to develop and improve the service capacity of facilities	Robustness, adaptability, flexibility
governance	Social dimension	Through regeneration creates areas that meet the needs of different groups, can bring new vitality through the interaction of multiple age groups and types of people, and can quickly respond to risks	Resourcefulness and rapidity

4. Result：Regeneration strategy for the Erqi Square area of Dalian

This section takes Erqi Square in Dalian as a case, applies the regeneration framework

incorporating the concept of resilience, and proposes the regeneration strategy for this area.

4.1 Overview of the Area

Dalian Erqi Square is located in the core area of the central urban area of Dalian, Liaoning Province, China, close to the core development axis of city's Qingniwa - Donggang core business and trade axis (figure.2). The initial construction of the area can be traced back to around 1890s. The area was built during the Russian occupation period, which is one of the origins of urban development in Dalian. The development of the area is also closely related to the development of the city. The initial construction made the area form a radial road network texture. During the period of Japanese occupation from 1904 to 1945, the area developed and expanded, gradually developing the functions of production, residence and commerce. On the basis of the original radial road network, a grid road network was built, forming a grid block. From 1945 to 1970, the area mainly developed industrial related functions. In the early stage, it was mainly used as a processing and transit base for products such as refined oil and chemicals. The corresponding dynamic area was also concentrated near the factory. In the later stage, it was mainly used as a chemical area of the port to develop a comprehensive industrial zone. After the 1970s, some enterprises in the central urban area moved out to the peripheral industrial zones and economic development zones. The industry of the area gradually moved out, and commerce and trade began to flourish from scratch. In the middle and late 1990s, residential clusters with relatively complete functions were formed, and the land use construction was basically saturated. Today, the commerce and trade industry in the area is no longer prosperous and gradually declining, but with the development of the city and the emergence of the new economy, it tries to introduce new business forms.

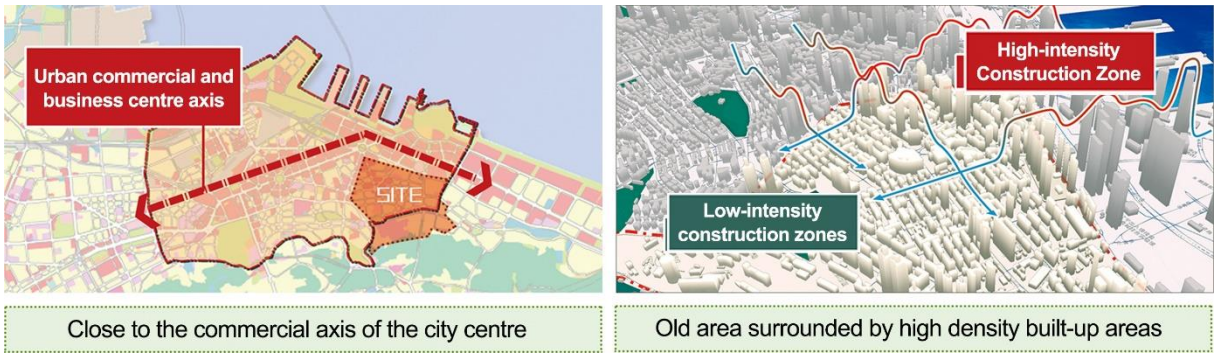

Figure 2. Diagram showing the location and extent of Erqi Square in Dalian

It can be seen that the selected area has a certain development history, and with the continuous development of the city, the area is also constantly changing, and has a

certain resilience in industrial development, functional adjustment and other aspects. However, it can also be seen that the development of this area mainly depends on the characteristics of the times. In the early stage of development, it focuses on responding to the needs of urban economic development. In the later stage, with the massive development and construction of the city, it has been transformed into a residential functional area. High density construction and the continuous decline of physical space have made the ability of the area to resist risks worse and worse, and it is urgent to regenerate.

4.2 Analysis of Area Problems

The development process of the area conforms to the development needs of the city at present, but the lack of strategic and sustainable vision in the early construction planning has left many problems in the Erqi Square area today.

4.2.1 The Physical Space Decays, The Space Is Over Saturated, And The Space Available For Emergency Is Occupied

Since the area was built in an early age, the existing buildings in the area also span many years, and the early buildings are now difficult to meet the needs of residents in terms of thermal insulation, safety, etc. In addition, the construction density of the area is extremely high, and few vacant land can be used as emergency space. The current small amount of vacant land or some public spaces are also often occupied in daily life. For example, due to the limited construction land that can be transformed in the old area, the high demolition cost, the difficulty of social parking lot construction, improper management, and unreasonable configuration of static traffic facilities, there is a large number of illegal parking and illegal occupation of sidewalks. It not only intensifies the contradiction between slow traffic and motor vehicle traffic, causing potential safety hazards, but also crowding out the space available for emergency use.

4.2.2 Serious Waterlogging In Rainy Season, Lack Of Disaster Prevention Space, And Large Potential Safety Hazards

This area is located in a mountainous area, affected by the terrain, and the area has always been facing the risk of flood disaster. Rainstorms caused by seasonal rainfall often lead to serious urban flooding and poor drainage in the rainy season. Although the existing drainage pipeline system operates normally at ordinary times, it still cannot meet the drainage demand in the rainy season. For example, in the summer of 2017, the commercial buildings around Erqi Square were flooded by the rainstorm, and the highest water can reach the waist, which has caused great hidden dangers for the safety of residents. In addition, the area lacks disaster prevention space. Because there are few green spaces, the disaster prevention space cannot penetrate into the city in combination with the green space system, and it is difficult to cope with sudden

disasters and risks.

4.2.3 The Area Is Not Well Connected, And The Trunk Road Traffic Is Blocked

The trunk road network in the area is concentrated in the west and north of the area. Donghai Thermal Power Plant in the northeast of the area and Dalian Naval Ship Academy (both large parcels of land) in the southwest block the east-west connection between the south and the north. The east and south of the area are lack of connection with trunk road network, and the east is especially lack of north-south connection. The disconnection of these roads leads to frequent traffic congestion in the area, especially during the weekday morning and evening rush hours. It is affected by commuting and by the arrival and departure of students from school. Congestion occurs mainly at the five-way intersections in the commercial area and at entrances and intersections near schools, affecting the smooth articulation of the area.

4.2.4 Public Service Facilities Are Not Matched With Crowd Demand

The existing educational service facilities in the area have low quality of spatial resource allocation, lack of street level cultural and sports facilities and social welfare facilities, which do not match the needs of the aging base. In terms of public space, there are only four squares for public activities in the area, and three squares except the Navy Square are traffic squares. The hard ground area is insufficient, and the crowd activity space is seriously lacking. The only large activity space in the area has low crowd concentration during leisure time. The Navy Square has too large green area, and the area available for activities is not large. The facilities are mostly memorial. There is no activity space and facilities for citizens' daily leisure, and most other places have no facilities, so the activity space and facilities do not match the needs of the crowd.

4.2.5 Strong Convergence Of Business Types And Declining Economic Vitality

The existing business types are converging. The financial industry in the area is dominated by banks and insurance companies, and most of them are bank outlets. The level is low, and the homogenization trend is increasingly serious. The trade industry in the area is dominated by food trade and daily general merchandise trade. Most trade companies have low registered capital, small scale and single business type.The Erqi Business Area, where the area is located, is far from the vision of the four business areas in the 14th Five Year Plan of Zhongshan Area. The gap between the Erqi Business Area and the surrounding Qingniwa Bridge Business Area is extremely wide. The concentration of brand stores is low, the business type is low-end, and the crowd attracted is mostly middle-aged and elderly people. The passenger flow is small, the stay time is short, the overall business strength is weak, and it gradually declines with the development of e-codismmerce in recent years.

In addition, the construction density of the area is too high, and the available space is insufficient, which is very unfavorable to the stable development of the area and the absorption and weakening of disturbance. In addition, the current situation of some regions, such as the age structure showing a high level of operation and the high degree of aging, can not be called a problem, but it is also not conducive to the rapid recovery of various systems in the region when disturbed.

4.3 Researching regenerable space in the area

The basic identification of regenerable spaces is often based on building quality and the renovation of major construction projects to identify regenerable plots. In a resilience perspective it is also necessary to focus on areas that are too poorly equipped to cope with risks in different dimensions, thus complementing the spaces that can and need to be regenerated. Therefore, firstly, through the analysis of building quality, age, construction density, and the type of business carried, the spaces that can be demolished and renovated are identified. Then, the requirements put forward by urban development are sorted out to identify the areas within the area that are affected by large construction projects, and some of these areas are designated as regenerable spaces in the light of the actual situation. Finally, in conjunction with the areas identified during the problem analysis as having greater safety risks, areas with very poor risk resilience and areas with the opportunity to be used as emergency space for disaster prevention, the spaces that must be retrofitted to improve resilience are identified to form an overall regenerable space for the area (figure.3, figure.4).

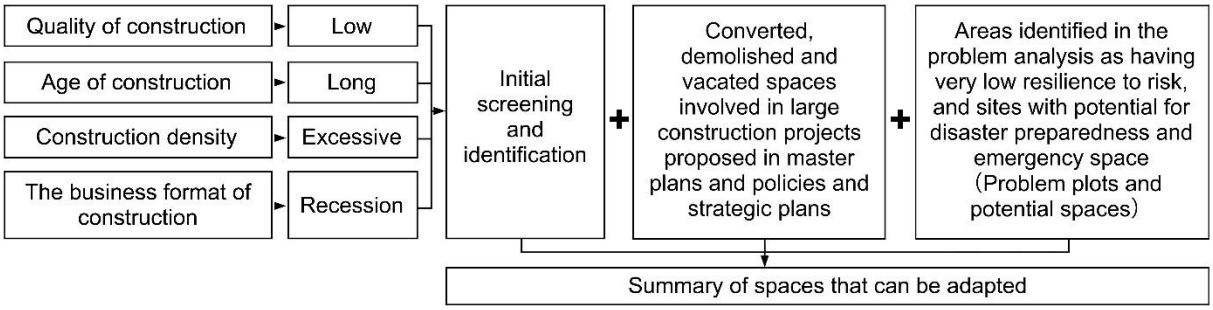

Figure 3. Determination of regenerable space

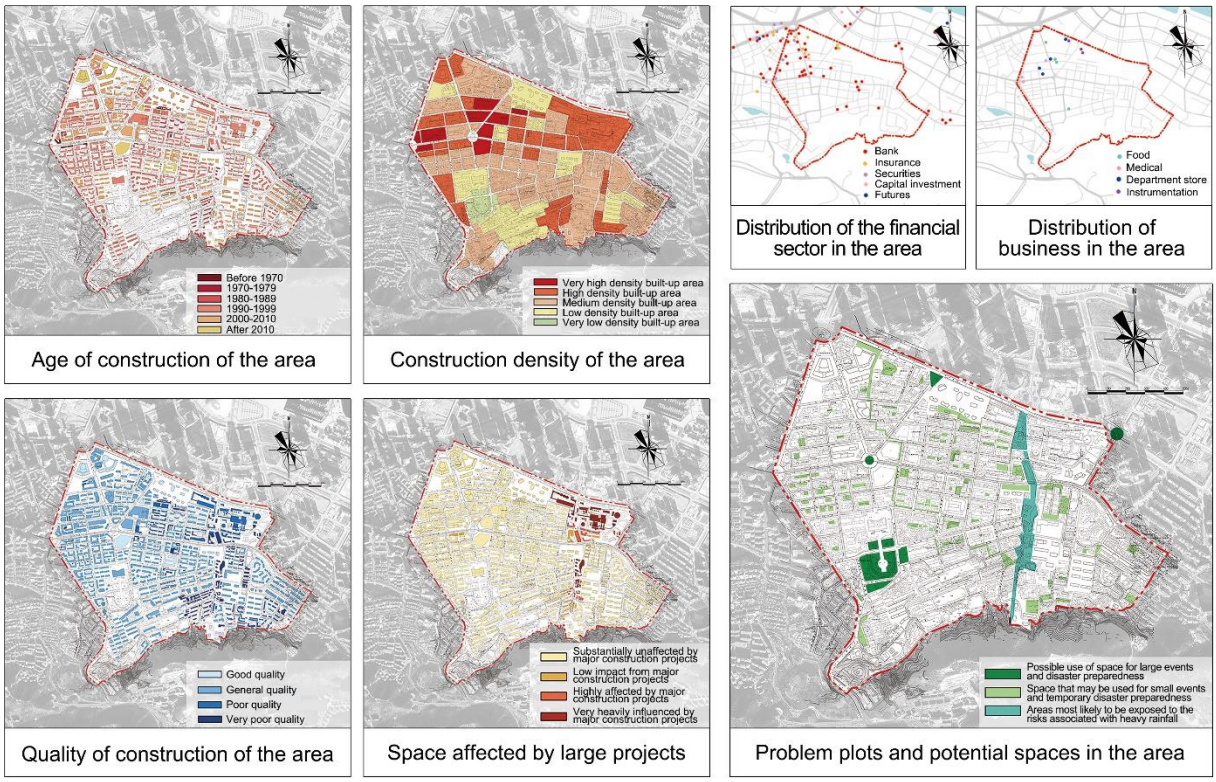

Figure 4. The process of identifying regenerable spaces in the Erqi Square area

4.4 Propose the regeneration strategy incorporating the concept of resilience

4.4.1 Area Regeneration Strategy at The Ecological Level: Resilient Thinking Integrated into The Environmental Dimension

(1) Reconstructing the Ecological Environment with Risk Absorption Capacity: Re-convergence of water systems

A hydrological correlation analysis is carried out using GIS based on the elevation data for the area. Determine the catchment line, and redetermine the approximate location and flow direction of the generated water system in combination with the available space identified in the space evacuation strategy. 'Re-convergence' refers to the overall sorting and updating of the base drainage system in conjunction with the newly created water system and the existing municipal drainage system. The extent and size of the catchment area should be determined by how much water is collected in the area, and the new catchment area should be determined in relation to the height difference in the area. Combine the determined flow direction and catchment area of the water system with the existing rainwater pipeline to determine the starting point of the water system and the operation of the overall system of the combined drainage of the water system and pipeline, so as to build an ecological environment that can cope with rain flood

disasters (figure.5).

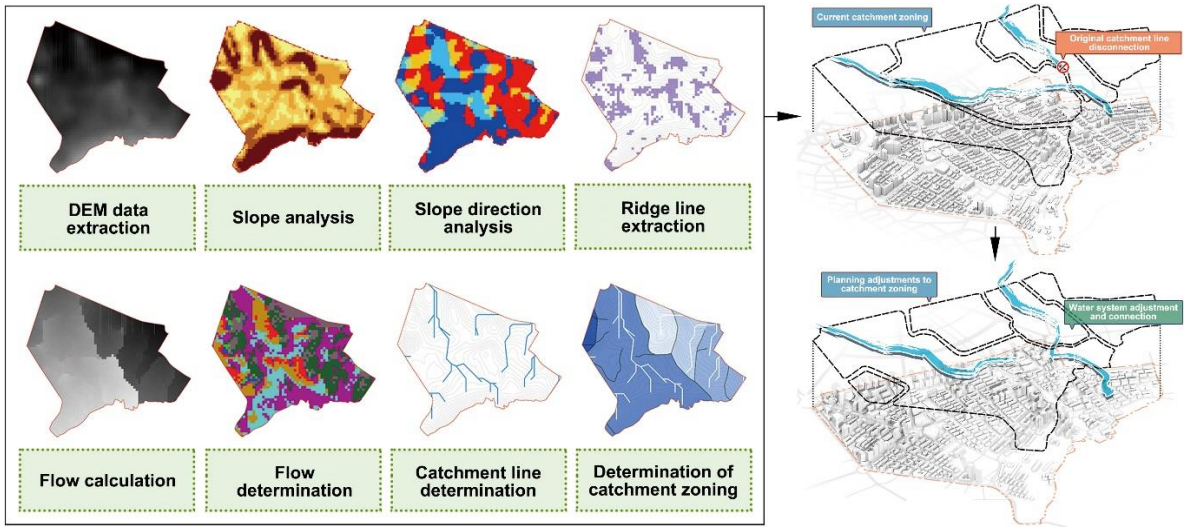

Figure 5. By using GIS analysis, the current catchment area was derived and the alignment of the water system was adjusted to take account of actual construction conditions

(2) Combining different levels of green space to enhance the area's ability to cope with disturbance

Existing ‘crevices’ that can be regenerated as ecological spaces are identified and regenerated. Green corridors, urban green spaces, community hard spaces and road green spaces are defined as ‘large crevices’, ‘small crevices’, ‘micro crevices’ and ‘line crevices' respectively (figure.6). The strategy transforms multiple 'gaps' - areas of the site that can be renewed as eco-spaces - and combines them in a synergistic way. The ‘large crevices’ are identified as the main skeleton, the ‘small crevices’ are identified as the main activity and landscape nodes, the ‘micro crevices’ are identified as the small scattered points that support the quality of life in the community. The ‘line crevices’ is a network that combines roads to connect the large and small crevices, building an ecological spatial network of the area and enhancing the ability to prevent daily climatic disasters.

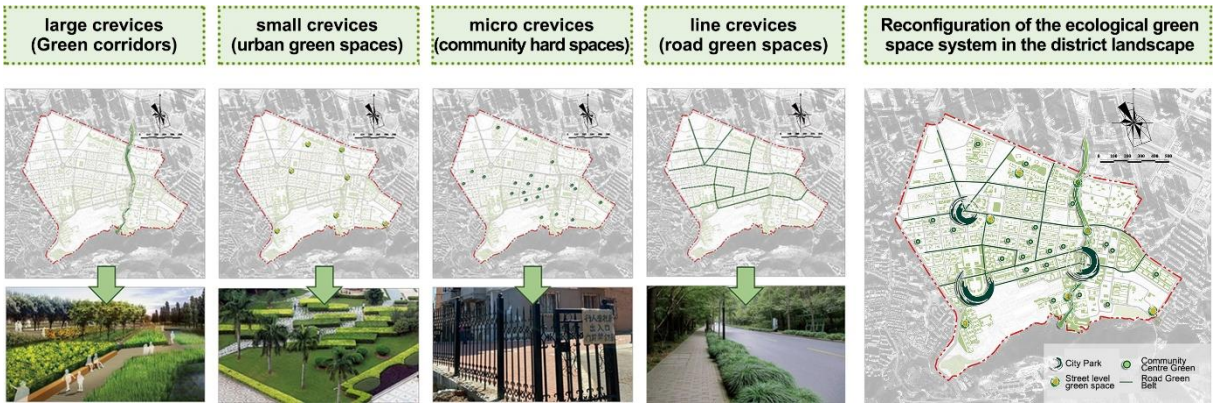

Figure 6. Identification and combination of different levels of green space

(3) Construction of sponge facilities to deal with risk disturbance

The construction of small and micro ecological environment shall be carried out in combination with different types of sponge facilities, including detention and infiltration facilities, transfer facilities, storage facilities and sewage interception and purification facilities. The detention and infiltration facilities include sunken green space, rainwater garden, permeable pavement and ecological tree pool, which can play a better role in rainwater storage and infiltration at the area level and community level. The transfer facilities are mainly grass planting ditches, and the storage facilities are mainly rainwater wetlands, which are arranged and used in combination with the construction of the central water system. The sewage interception and purification facilities are vegetation buffer zones, which combine the unique elevation difference terrain of Dalian to discharge and collect natural water bodies. In addition, to build a system of sponge facilities at both the area level and community level is also important (Figure.7). The construction of sponge facilities is conducive to maintaining the stability of urban ecological environment, urban flood control and waterlogging prevention, increasing landscape greening, and providing better living environment for residents.

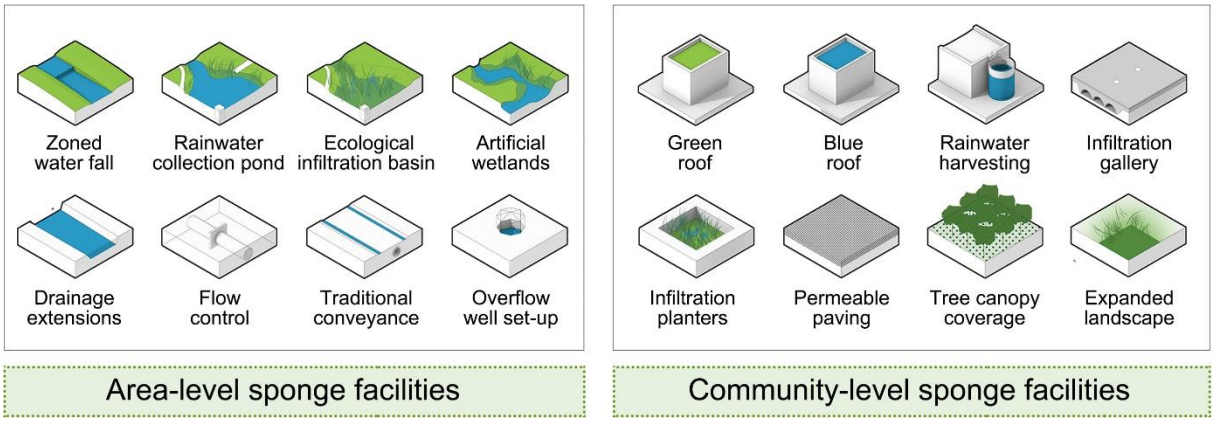

Figure 7. Area-level and community-level sponge facilities (Reprinted from SASAKI,2016)

4.4.2 Area Regeneration Strategy At The Production Level - Resilient Thinking Integrated Into The Economic Dimension

(1) Reconstruction of industrial support system and introduction of diversified economic forms

Sort out the original industries that do not meet the needs of the current situation, and determine the future main development of ancillary industries and attracting industries in combination with the development goals of the area. 'Ancillary industries' mainly refer to the demand of the central business axis and Dalian Port for the surrounding areas, such as financial services, trade services, port and shipping services and other business formats. 'Attractive industries' are based on the location of the area and its historical heritage, mainly include market commerce, speciality catering, tourism and cultural and creative industries. In conjunction with the reconfiguration of the industries, a diversified economic form is introduced, such as the floor stall economy and the creative economy. The area's economic and social diversity will be maintained by bringing in people from all walks of life.

(2) Adjustment of business structure and business model

It is proposed that some industries that are no longer suitable for development in the area, such as Donghai Thermal Power Plant, wholesale markets such as auto repair market, and some enterprises that have closed down should be abandoned. On the basis of upgrading the original reserved industries, such as market commerce, financial services, and commercial services, new industries such as cultural and creative industries, tourism industries, and specialty catering industries should be cultivated and developed. In addition, it is important to establish a business model that combines market and public interest and to avoid a single form of economy dominated by the market. In the regeneration of public service facilities such as sports facilities, elderly facilities and other facilities, a semi-market and semi-community operation model is adopted to meet the needs of the residents in the area while ensuring the possibility of diversified development in the area.

4.4.3 Area Regeneration Strategy At The Life Level - Resilient Thinking Integrated Into The Engineering Dimension

(1) Reconstruction of public open space provides residents with communication space

Combined with the exploration of renewable spaces, the public open space system of the district is reconstructed by reusing spaces with potential for renewal. The original large open spaces in the area will be retained and combined with demolition and redevelopment to create community-level public spaces, and with the transformation of

the hard land between houses to create public spaces between houses, solving the problem of the original open space with little land and a single function. This strategy can increase the interaction of residents and promote social ties by increasing the number of activity spaces.

(2) A series of traffic measures to ease the traffic in the area

Based on the current characteristics of the roads on the base and the preservation, demolition and transformation of the space, sort out the roads that can be and need to be altered. The plan divides the entire road system into current preservation roads, roads with partial adjustments and roads undergoing complete renovation. Different strategies are used to alleviate traffic congestion depending on the different problems that exist on the different roads. The specific strategy can be found in figure 8 and table 2.

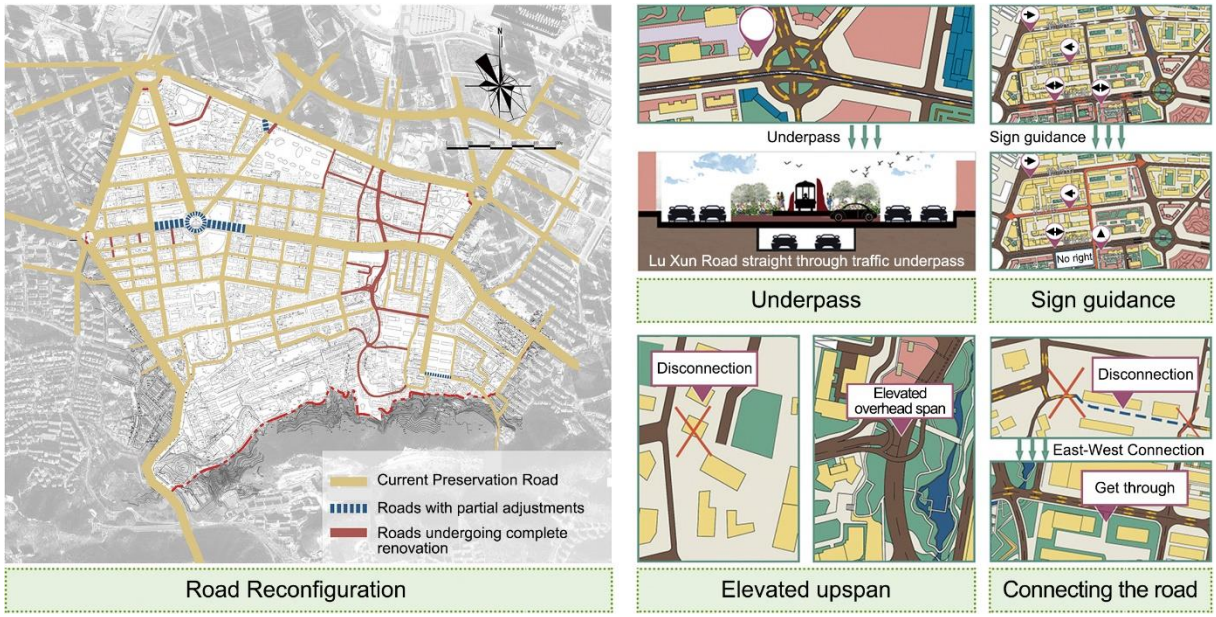

Figure 8. Illustration of the regeneration measures for traffic in the Erqi Square area

Table 2. Diversified measures to relieve traffic in the area

take steps	concrete content	Regenerate results

Elevated upspan	In the gully section in the southeast of the plot, due to its own elevation difference, the road traffic is disconnected from east to west and the connection is not convenient. In combination with the response space vacated by the reconstruction of the ecosystem, the elevated upper span is used to enhance the multi-directional connectivity of the area	It ensures the efficient use of space, improves the connection of north-south trunk roads in the east of the area, and enhances the connectivity of the area
Underpass	In order to ease the traffic in Erqi Square, it is planned to lead the traffic directly through Lu Xun Road through the tunnel to the underground of Erqi Square, and the traffic from Lu Xun Road to Gangwan Street and Dazhong Street will drive around Erqi Square counterclockwise	The traffic operation at the intersection is relieved, and the potential safety hazards are reduced. The underpass provides new traffic path choices, increasing flexibility and redundancy
Sign guidance	The traffic section between March 8th Square and Erqi Square is prone to congestion. It is planned to direct the traffic flow of the open block to the north of Sun Street, set up stop right turn signs at the intersection of Lu Xun Road and Sun Street, and guide the traffic flow to the destination by taking advantage of the characteristics of Beidou Street and Qinjian Street, which are one-way right and one-way left.	Make full use of the existing space, relieve the traffic pressure on the main roads, reduce the potential safety hazards, and enhance the robustness of the operation of the area during peak hours
Time-sharing parking	Integrate road resources, reasonably use redundant roads to set up time-sharing roadside parking, and the parking space planning should follow the principle of ‘reducing interference streamline, clear, convenient and moderate space for passengers to drop off’.	Make full use of existing resources, reflecting the resourcefulness of space

Smart management	Through the management means of intelligent parking, the integrated development of finding parking spaces, parking, calculating parking time, paying fees, and driving away will be further strengthened, and the construction and operation of the static traffic system will be further strengthened.	It makes the space utilization of the area more reasonable, and is conducive to forecasting the traffic flow, vehicle ownership, etc., so as to provide reference for the future regenerate of the area

(3) Upgrading public services to meet different needs and situations

In view of the low quality of primary and secondary schools and medical facilities in the planned public service system, based on the management and control standard, plan the expandable space, leave it for aging and upgrading, and transform and improve the existing regenerable land. Areas that do not currently meet the transformation requirements but where there is a need for renewal can be renewed on an ongoing basis as the area develops, and when their quality meets the transformation requirements, or when the impact of a major project provides an opportunity for transformation, then the corresponding facilities can be transformed, but with the potential space left in advance (figure.9).

For the social welfare facilities and cultural, sports and recreational facilities that are currently lacking, there is a need to combine the demolition and renovation of renewable spaces and to implant social welfare facilities and cultural, sports and recreational facilities in the vacant land after the demolition of buildings in a graded manner. At the same time, it is necessary to combine the semi-market and semi-community operation mode of the industrial strategy to improve the quality of the existing public service facilities in the area, to supplement the missing service functions in the area and to enhance the public service capacity within the area.

In addition, the time-sharing of some areas can also ensure the effective use of various urban spaces and the satisfaction of public service space needs. For example, some kindergartens themselves do not have enough space for activities, so the administrators can open the surrounding public green areas on a time-sharing basis, only provide children with access to them at certain times, thus relieving the pressure on the tight public service space (figure.9).

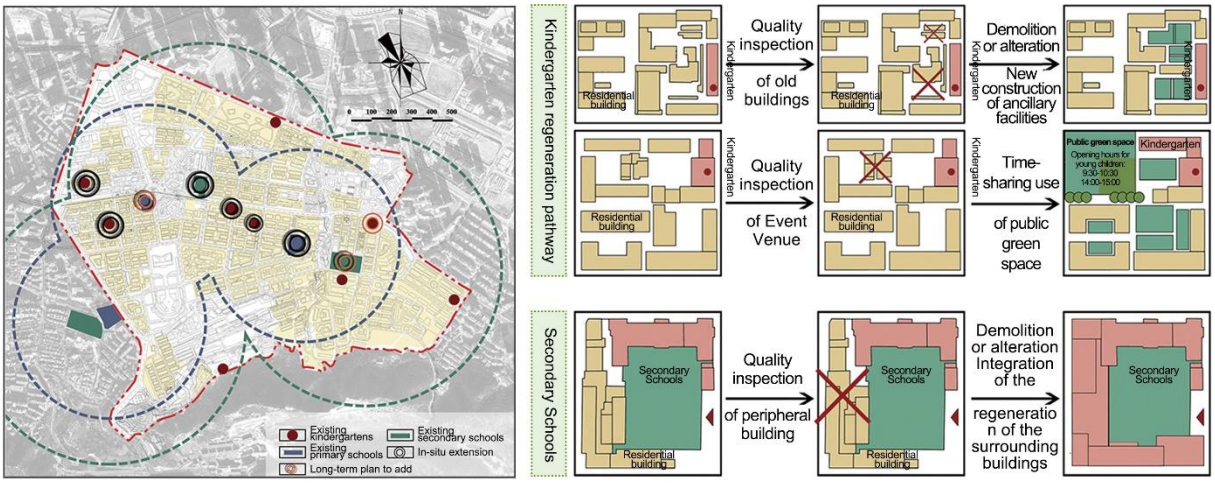

Figure 9. Proposing a model for facility quality improvement using educational facilities as an example

4.4.4 Co Construction And Co Governance Strategy Of The Region - Resilient Thinking Integrated Into The Social Dimension

(1) All interest groups jointly negotiate the planning and construction of the future area

The development of the area requires the entry of capital and the vitality of the residents. In addition, the government's requirements for urban development will also be reflected in the achievements of the area construction, so the future construction and development of the area cannot be separated from these three factors. The lack of any party in the construction of the area will make the future development of the area unbalanced, thus weakening, or losing the ability to operate stably and healthily and resist risks in all aspects. Therefore, the ‘co construction’ strategy is proposed in the renovation of Erqi Square area to consider costs and benefits, and try to reduce costs and improve benefits. The construction and development of the area needs the joint participation of multiple subjects involved in the area. The participants involved here mainly include three parties, namely the government, developers and indigenous people. The needs, bottom line of interests and restrictions of the three parties are different. It is necessary to balance the needs and interests of the three parties to achieve solutions that meet the requirements of all parties, and avoid the implementation and regenerate risks caused by conflicting opinions (figure.10).

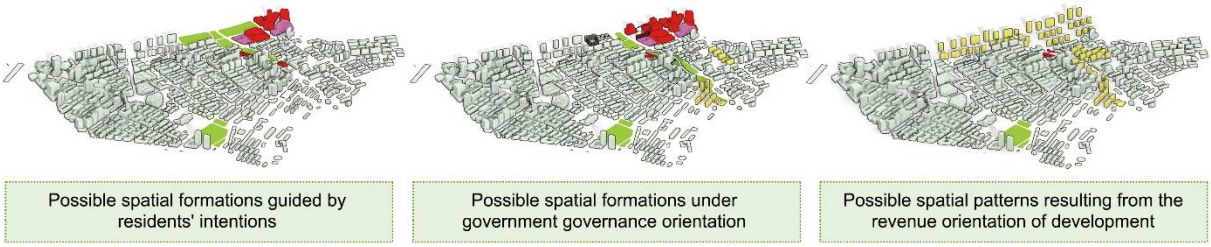

Figure 10. Illustration of the process of multi-stakehold coordination programme

(2) Multi-social actors jointly participate in the governance of the area

The participation of multiple social entities in governance is mainly to respond to the occurrence of special circumstances. For example, during the COVID-19 epidemic period, community governance is difficult to rely on only a few community managers. Therefore, in the process of daily management and governance, the participation of multiple social entities should be considered, such as expanding the owner's committee, allowing people from different professions in the area to participate in governance, and determining volunteers for each building in the community. This management and coordination system is difficult to establish temporarily in the event of a disaster, so it is necessary to build a governance structure with the participation of multiple social subjects on a daily basis. It is proposed to adopt a win-win organization operation mode of multi-party cooperation game, which can enhance the ability of the area to deal with uncertainty by enhancing multi-party group cooperation.

5. Discussion

Integrating the concept of resilience in the regeneration of old areas does not only mean building or enhancing resilience in the outcome of regeneration, but also focusing on the excavation and construction of the changing and transforming capacity of the system in the whole process of regeneration, emphasising the attention to the different stages of risk and the response and correspondence to the characteristics of resilience in different stages. Based on the analysis of the concept of resilience and the case study of the regeneration of Erqi Square, the regeneration of old urban areas from a resilience perspective should integrate the concept of resilience into multiple stages of regeneration, and also consider the construction of resilience of different systems in the detailed path of regeneration.

In terms of the overall objective of regeneration, emphasis needs to be placed on the enhancement of the ability to cope with, adapt to and recover from risks, and the construction of resilience should be incorporated into the overall regeneration objective when it is first defined, so that in addition to solving the existing problems of the old

district, more emphasis should be placed on enhancing the ability of the old district to cope with different types of risks, so that the district finally has the ability to self-regulate and continuously adjust and optimise. In terms of regeneration methods and paths, the systems to be regenerated need to be split up, and the final regeneration outcomes achieved after incorporating the concept of resilience should be considered in different dimensions, reflecting a progressive process of continuous renewal and transformation in the regeneration paths of different systems. The update outcome of the different systems should reflect the improvement of the resilience to disturbances in different dimensions and the increase of the threshold for the risk of a sudden drop in system performance.

6. Conclusion

This paper aims to build a framework and content for the renewal of old urban areas from a resilience perspective. Based on a review of existing literature, it clarifies the meaning of resilience in the renewal of old urban areas and constructs a resilience analysis framework that includes four dimensions: economic, engineering, environmental and social. A three-stage research process is proposed, from the exploring the problems of old areas, the search for regeneration space to the proposal for a regeneration strategy that incorporates the concept of resilience. A regeneration strategy that incorporates the concept of resilience is proposed based on the actual case of the Erqi Square area in Dalian. Thereafter, a discussion based on the case study is presented. The study expects to provide some reference for the application and theoretical perceptions of the concept of resilience in regeneration.

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