

Review, Experience Summary, and Prospects of Macao's Modern and Contemporary Urban Development Trajectory

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Abstract: As a core city in the Guangdong-Hong Kong-Macao Greater Bay Area, Macao carries a rich urban history spanning several centuries. Existing scholarship has examined Macao's urban development from multiple perspectives, including political institutions, urban space, construction, and planning, yet it has not sufficiently highlighted the foundational role played by the transplantation of the Portuguese urban planning system into Macao. Using the theme-river visualization tool, this paper maps the trajectory of Macao's urban development from 1845 to 2022 and divides it into five periods: the period of implementing colonial rule, the period of consolidating colonial rule, the neutral-zone development period, the period of high regional autonomy, and the new era of "One Country, Two Systems." The study finds that Macao's modern and contemporary urban development has been driven by six interrelated logics: population change as a reflection of political fluctuation; land expansion as a record of urban fabric evolution; legal norms as safeguards for orderly development; urban objectives shifting from individual buildings to regional integration; the continuous improvement of existing environmental quality; and forward-looking planning grounded in the anticipation of demand. The paper concludes that Macao's urban development demonstrates several strengths, including breakthroughs generated by volatility, the prevention of deferred and entrenched conflicts, regulatory guidance through improved laws, attention to development constraints, refined demand orientation, and phased prospective planning. These experiences provide valuable historical insights, development paradigms, and future perspectives for analyzing the development logic of other cities.

Keywords: history of urban planning; modern urbanization; Macao; theme river

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Macao's modern and contemporary urban construction began in 1845, when Portugal seized administrative authority. Over several centuries, traces of colonial and autonomous governance accumulated in this compact territory, giving Macao distinctive features in government control, capital flows, environmental improvement, heritage conservation, welfare provision, public health, and disaster prevention[1]. As an open meeting point of Eastern and Western trade and culture, Macao entered a new phase of development after its return to China. Existing studies[2-5] have proposed different logics for dividing Macao's urban development and have repeatedly noted weak planning and constraints on development. This paper reviews Macao's modern and contemporary urban development, reveals its deeper development logics and points of breakthrough, and summarizes the city's historical experience.

1 The development history of modern and contemporary Macao

Many scholars have studied Macao's urban development from different logical perspectives, using history to inform the present and focusing on political systems, urban space, urban construction, and planning ideas[6].

1.1 Political fluctuation and multiple breakthroughs

Lou Shenghua[7] once described the Portuguese Macao government as exhibiting the traits of "weak governance": governing through non-intervention, limited action, simplified objectives, and indirect social control. This feature gave Macao's urban development a high degree of sensitivity. Under special changes in the political environment, the city showed pronounced phased transformations in control, trade, and population.

The evolution of governance under Chinese-Portuguese divided administration reveals how different forces influenced development through conflicts of interest, leading to the proposition of "two cores and three communities, with Chinese and Portuguese communities coexisting"[8-9]. On this basis, scholars have divided Macao's development into four periods: the Catholic city (1557-1840), colonial development (1840-1911), regulatory improvement (1911-1974), and autonomous planning (1974-1999)[6,9-12]. These studies show the overall nature of development under the extension of colonial rule from the peninsula to the whole territory. Although they consider the influence of the Portuguese planning system, they do not fully reveal why planning and control changed and improved behind colonial policies[6,10].

Economic trade was shaped by external factors, including global policies①, and by special groups such as Chinese merchants. These forces changed Chinese and foreign capital and population composition and promoted Macao's transition from a traditional fishing and agricultural society to a modern commercial society[8,13-14]. In this process, Chinese communities helped shift Macao's value from commerce toward diplomacy and became a link between Chinese and Portuguese development. The resulting economic and political interests stimulated population inflows and urban growth[14-16]. Macao's development amid political fluctuation has been described as an interweaving of socialism, colonialism, capitalism, and development blueprints; in the collision of multiple ideas, the city continuously achieved breakthroughs that were reflected in spatial change[17].

1.2 Urban space and legally secured land rights

Macao's urban space is characterized by mountain-sea boundaries and compact construction. Rapid expansion can damage traditional landscapes, intensify the contradiction between people and land, and produce uneven public services, thereby reducing urban livability. This phenomenon is visible in the evolution of spatial form based on land reclamation[18-19].

Drawing on the reclamation time nodes identified by Huang Shixing, such as 1912 and 1936, scholars[20-24] have described the formation of Macao's land area through four stages: construction exploration (1557-1840), colonial reclamation and expansion (1840-1974), steady autonomous development (1974-1999), and rapid post-return construction (1999 to the present). Li Qinru[25] further divides reclamation into the western Inner Harbor and northern peninsula reclamation (1850-1912), the eastern and northern peninsula reclamation (1912-1936), and subsequent Cotai reclamation. The spatial evolution caused by reclamation is corroborated by Chen Mingfa et al.[26] in their study of impervious surfaces② in Macao: after 1990, the peninsula could no longer expand, and development began to shift toward Taipa, Coloane, and new districts.

The government also increased legal control over land, particularly in the protection of property rights. The evolution of the property-rights system affected construction and development in every period of Macao. Chen Jiahui[27] studied how laws made by Portugal and extended to Macao affected land legislation, while Liu Yongde[28] analyzed the causes of the unique difficulty of "Sa Zhi Qi"③. Although some scholars[29] argue that legal constraints have hindered current urban renewal④, the influence of legal control on the logic of urban development has not yet been fully clarified.

1.3 Urban construction and Sino-Western interweaving

Mo Xiaoye[30] analyzed urban construction through local illustrated gazetteers and summarized its characteristics as improved transportation, increasing Western-style buildings, and taller buildings. Guo Shuling[31] regarded 1888 as a node of early road construction. On this basis, Feng Chen et al.[32] analyzed street changes in 1834, 1889, 1952, and 2010 and described the process as a regularized evolution toward openness, expansion, efficiency, and connectivity. Increasing density also triggered the relocation of the urban center. This phenomenon has been described as outward dynamic extension closely related to political fluctuation and spatial development, forming a single fringe belt (1840-1911), a double fringe belt (1912-1980), and a triple fringe belt (1980 to the present), and showing a shift in construction models from "monumental buildings and straight streets" to "two cores and three districts," parish-based development, and a "dual-port model"[33-36].

Differences among these models influenced the construction and transformation of buildings in different periods[37-38]. Zhao Shuhong[39] found that building materials shifted from wood and brick to stone and concrete, and building organization shifted from single structures to complex building groups. Later scholars[40-42] supplemented this with three stages: stagnation (1930-1960), high speed (1970-1980), and reflection (1980 to the present). During these stages, buildings began to be modernized, and considerations of function and internal spatial practicality increasingly outweighed concerns for form and formal creativity. This architectural evolution linked styles such as bamboo-tube shop houses, Portuguese architecture, simple residences, and modern towers, creating a distinctive streetscape[43-44].

Macao's construction characteristics were influenced by medieval European urban models. Although time has blurred the features of each stage, traces can still be seen in the regulations followed by different areas[45-46]. The government has used rectification and planning to promote regional integration, but development has continued to face multiple obstacles, including conflicts between Chinese and Western ideas, discontinuities in the planning system, shortages of land resources, and difficulties in renovating old neighborhoods[47-50].

1.4 Planning ideas and coordinated advancement

Guo Zhan[51] argued that World Heritage is the foundation of Macao's planning. Wen Ya[52], however, found that after 1963 planning ideas evolved through reliance on government guidance, legislative exploration, and improvement. This shift in ideas encouraged scholars to consider development from multiple dimensions.

On the basis of environmental improvement and economic development, Yang Yan[4] divided Macao's development into the demarcation of new boundaries (1845-1867), environmental improvement (1867-1918), rapid urbanization (1918-1942), slow development (1942-1956), overall beautification (1956-1975), new district development (1975-1998), and regional planning (1998-1999), and examined morphological evolution and street collage in detail. Zheng Jianyi[3], focusing on the Inner Harbor, used politics, economy, geography, and maps to divide the area into initial formation (1557-1840), formation (1841-1900), transformation (1901-1980s), and decline (1980s to the present).

In recent years, renewal and regional cooperation have become key themes. Yao Zhihao et al.[5] argued that renewal concepts evolved from problem orientation, through legislative coordination, to institutional construction. Zhao Songjie[53] studied peninsula transformation after 1880 and proposed a multi-phase, multi-area transformation model that preserved local customs. Liu Minshi[2] divided public participation into germination (before 1999), experimentation (1999-2016), and implementation (2016 to the present). Jing Tao[54] summarized the development of the Guangdong-Hong Kong-Macao region as sequential development (before 1949), mutual isolation (1949-1978), "front shop and back factory" (1978-1999), and deep cooperation (1999 to the present). Considering cross-border cooperation mechanisms and population flows, Macao urgently needs to deepen its path of coordinated development in the Greater Bay Area, build multi-level regional policy-coupling mechanisms, and accelerate factor circulation in the new development cycle[19,55-56].

1.5 Comparative review

Focusing on Macao's urban construction and development from 1845, when Portugal unilaterally declared Macao a "free port," to the promulgation of the urban renewal law in 2022, and combining existing periodizations based on political systems, space, construction, and planning ideas, this paper finds that scholars generally recognize the occupation of Coloane in 1911, the 1912 Macao General Plan, the 1948 Prosper Macao Plan, and the 1974 April 25 Revolution as development nodes. Some also regard the 1979 Overall Rectification Plan of Macao and old-district redevelopment activities as markers of urban expansion and environmental improvement.

Although some scholars[3-4] note that modern Macao planning had the typical features of European traditional commercial core areas and was influenced to some extent by Portuguese planning paradigms, this influence has not been incorporated into existing development periodizations. Existing divisions lack general applicability and fail to clarify the distinctive features and underlying development logic of Macao in different stages. Therefore, this paper proposes a new periodization of Macao's development in order to analyze its modern and contemporary urban trajectory and future direction more accurately.

2 Periodization of modern and contemporary urban development in Macao

2.1 Selection of urban affairs

This study adopts the Research on the Outline of Macao Urban Planning for the 21st Century, prepared at the time of the 1999 handover, as its main reference framework. It also draws on key planning materials such as the Municipal Code of the Macao Municipal Council and the Macao Special Administrative Region Urban Master Plan (2020-2040). Urban affairs are divided into 21 categories: regulations, political system, planning, external relations, supervision, population, land, commerce, taxation, housing, internal transport, external transport, geographical environment, media, cultural heritage protection, public space, public services, infrastructure, tourism, welfare, and public health and disaster prevention[57]. Urban affairs are closely linked to development, as seen in the precise implementation of government blueprints and the optimization of public feedback. Based on existing studies and Macao's historical materials^⑤, nearly 1,800 urban-development-related affairs from 1845 to 2022 were compiled[3,4,31,33,58-61].

2.2 Assignment and organization of affair tendencies

The assignment and organization of affair tendencies essentially transforms qualitative content into quantitative indicators through structured textual data, providing an operational framework for historical development analysis. First, descriptions in textual records are identified and assigned values according to their degree of association with a given category. If a text clearly contains content related to a category, it is assigned a value of 1; otherwise it is assigned 0. Second, the values of all affairs in a given year are summed to obtain the annual total for each affair category. Third, based on these sums, tendency values are calculated again to produce annual affair-tendency data. Through systematic analysis of the annual affairs from 1845 to 2022, the study ultimately compiles Macao's annual affair-tendency data across the modern and contemporary time dimension.

2.3 Division of development stages

A theme-river diagram can intuitively show the dynamic changes of events over time. It not only clarifies the evolution of affairs but also helps identify key factors affecting their progression. In addition, it compares the mutual relations and proportional changes among multiple themes, thereby revealing their fluctuating trends.

The annual affair-tendency data from 1845 to 2022 were summarized and visualized in a single-affair trend diagram in the style of a theme river [Fig. 1(a)]. The horizontal axis represents time and the vertical axis represents the proportion of different affair categories at each time point. The diagram shows that Macao's urban

development affairs became increasingly comprehensive and balanced over time, but it does not clearly reveal the logic of urban evolution.

Since multiple categories of affairs often work together to guide the improvement of a particular aspect of urban development - such as land issues, housing optimization, urban renewal, and transport improvement - the study assigns values to these composite affairs and draws a composite-affair trend diagram [Fig. 1(b)]. This reveals that Macao has placed increasing emphasis on integrated urban development, with a clear alternating pattern of "rise-stability."

Affairs also exhibit a degree of lag: policies issued in one year may only drive construction in later years. Therefore, when identifying nodes at which the composite-affair trend changes significantly and relating them to single-affair trends, the study selects relevant affairs in advance. It identifies five nodes in modern and contemporary Macao: Portugal's seizure of governing authority in 1845; the application of the Portuguese Civil Code to Macao and the formulation of special regulations in 1879; the development of Macao as a neutral zone during the Pacific War in 1941; the implementation of decolonization policies in Macao after Portugal's April 25 Revolution in 1974; and Macao's return to China in 1999 and the implementation of "One Country, Two Systems." Based on these nodes, Macao's modern and contemporary development is divided into five periods: the period of Portuguese implementation of colonial rule (1845-1879); the period of consolidated colonial rule based on the Portuguese legal system (1880-1940); the neutral-zone development period amid wartime turbulence (1941-1973); the period of high regional autonomy under the influence of decolonization policy (1974-1999); and the urban development period guided by "One Country, Two Systems" and Greater Bay Area construction (1999 to the present).

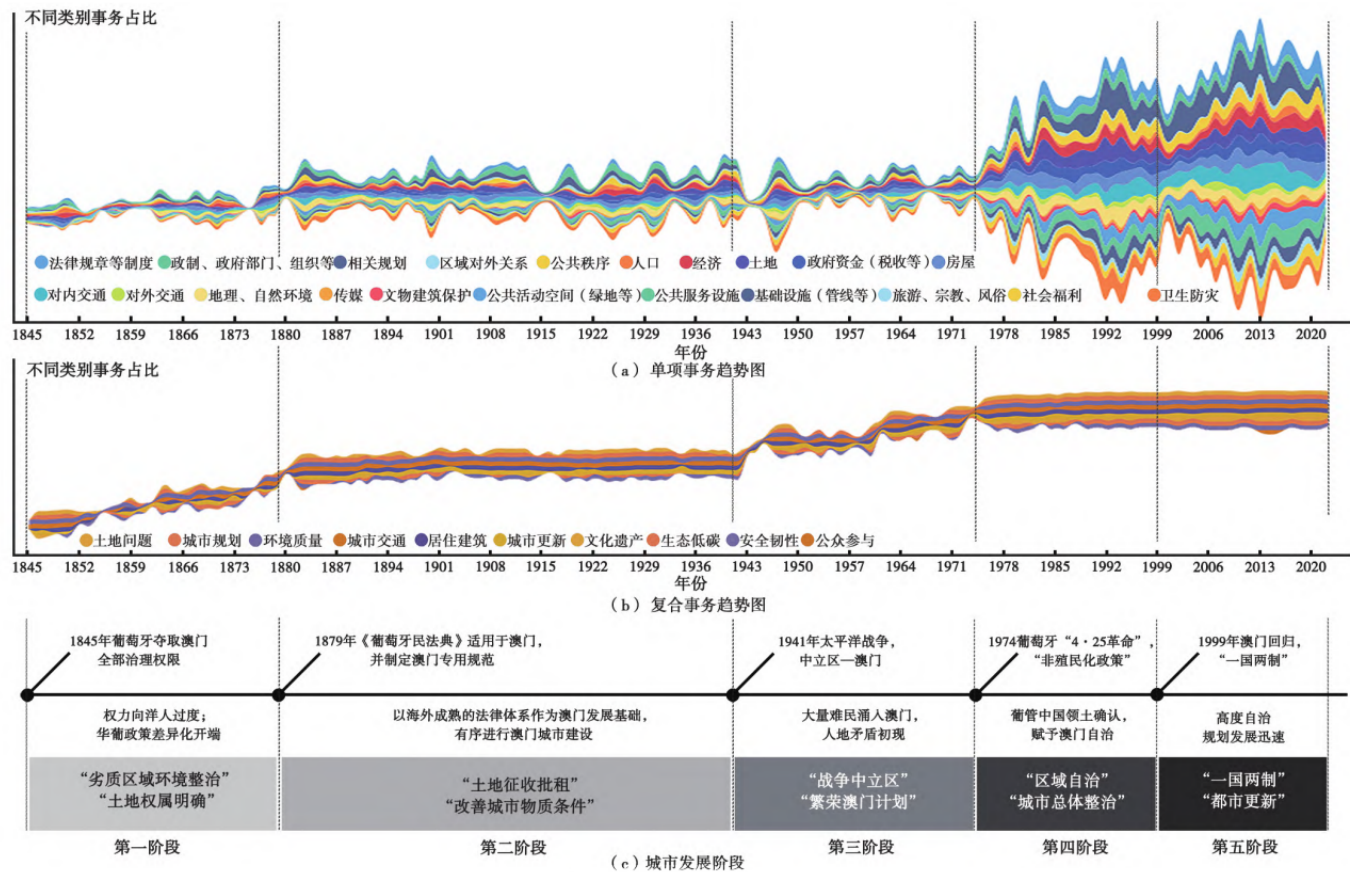


Fig. 1 Different stages of modern and contemporary urban development in Macao

2.4 Overview of the development periods of modern and contemporary Macao

2.4.1 Period of Portuguese implementation of colonial rule (1845-1879)

Under colonial policies of "rectifying poor regional environments" and "clarifying land ownership," the government occupied land and prioritized the land it obtained for urban construction. Policies on specific matters such as public health^⑥, roads, and buildings were not yet systematic, but they improved living conditions, addressed problems of fragmented land rights, weak regional connections, lack of vegetation, and sanitation, and clarified that urban and building construction should follow planning and building requirements. Although these policies ostensibly improved the living environment of residents, they also paved the way for Portuguese privileges. For the first time, construction form was determined through drawings, with consideration given to terrain, greening, and the ratio of streets and lanes, thereby clarifying building standards.

2.4.2 Consolidated colonial rule based on the Portuguese legal system (1880-1940)

Under the influence of the mature Portuguese legal system, the Portuguese Macao government built a legal and construction-regulatory framework suited to Macao. This framework became the foundation for subsequent regulations and policies and an important basis for operation and management. During this period, rectification and planning were mostly problem-solving in nature. Policies such as "land expropriation and lease" and "improving urban material conditions" consolidated colonial rule, strengthened the management of land ownership, and improved residents' living quality. The Public Works Department took charge of all building and public works. The government proposed calculating plot population density, constructing roads, greening, buildings, and pipelines in sequence, and using plans to restrict building form. Planning was regarded as beneficial to public health; buildings that obstructed development should be purchased and demolished, and renewal could be financed partly by lottery revenue. Successful rectification cases were promoted to improve living conditions, marking the embryonic stage of Macao's planning and construction.

2.4.3 Neutral-zone development amid wartime turbulence (1941-1973)

War in surrounding regions drove large numbers of refugees into neutral-zone Macao. Turbulent social conditions, urban construction, and public health and safety became major challenges. In the early and late parts of this period, unstable government rule and riots appeared, and the city experienced disorderly development and even counter-urbanization, with numerous building activities ignoring government control. This pressure pushed the government to adopt proactive and forward-looking measures in planning and governance. Departments were reorganized to formulate relatively complete development plans, strategies were proposed for heritage and transport issues, and the Prosper Macao Plan and the Urban Beautification Movement were launched. The street-alignment plan and the public housing system became the predecessors of current building standards and the public housing system. Building reconstruction and maintenance were regulated, roads and the environment were continuously optimized, and regional comprehensive reconstruction and owner-initiated facade changes emerged. However, the plans and regulations were responses to emergencies rather than parts of a coherent system.

2.4.4 High regional autonomy under the influence of decolonization policy (1974-1999)

Under the influence of the late third period and Portugal's decolonization policy, planning and construction activities returned to normal and developed fully. Under high regional autonomy, the urban construction system was improved and "overall urban rectification" was promoted. Large-scale construction improved living conditions; more complete rules on housing allocation and construction also led to a peak in building activity. Working groups were established to study housing, transport, and facilities, and planning and regulatory means were used to address land, transport, and residential issues. The idea of dividing areas according to their

development conditions and architectural characteristics laid the foundation for later strategies of regional revitalization. The idea of self-management of housing was also promoted through clarified land rights, sanitation management scopes, and tax incentives.

2.4.5 Urban development under "One Country, Two Systems" and Greater Bay Area construction (1999 to the present)

After the implementation of "One Country, Two Systems" and "Macao people administering Macao" with a high degree of autonomy, planning and renewal systems were promoted through legislation and government organization to respond to needs in land, transport, buildings, and the environment. This stage attaches particular importance to professional technologies such as planning and improves policies and regulations throughout the entire development process, from master planning, regional revitalization, and disaster prevention to building construction, material use, and recycling. The Guangdong-Hong Kong-Macao Greater Bay Area has also provided a broad development platform for Macao. The Guangdong-Macao Cooperation Framework Agreement has promoted development coordination in new-district development and environmental improvement[62-64]. In addition, collaborative waste treatment and carbon-reduction cooperation in the building sector have placed higher requirements on Macao's future urban construction and renewal[65].

3 Analysis of the evolution of Macao's urban development trajectory

Based on existing studies and the trend of affair evolution (Fig. 2), this paper analyzes six major urban development trajectories: population fluctuation, land expansion, regulatory safeguards, architectural foundations, quality improvement, and demand insight.

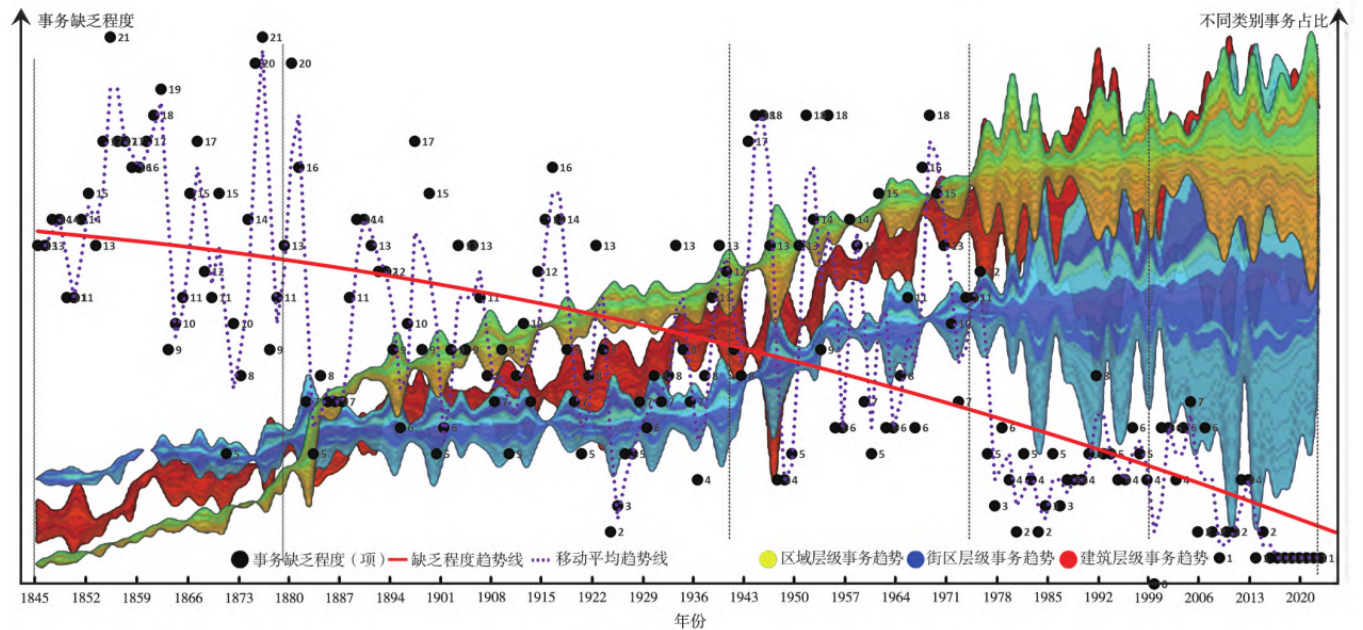


Fig. 2 Evolutionary trend of modern and contemporary affairs in Macao

3.1 Population change as a reflection of political fluctuation

The core relationship between political fluctuation and urban development is reflected in population dynamics. Relying on a relatively stable political and social environment, Macao formed a distinctive mechanism for absorbing population, and population change confirms the positive correlation between political stability and livability (Fig. 3). In the early period, the Portuguese Macao government incorporated Chinese residents into its control by occupying land, but the substantial population surge began during periods of war in surrounding

regions. As a neutral zone, Macao became a refuge for displaced people, and shantytown areas in the northern peninsula expanded rapidly to accommodate population[31]. Although this unplanned population growth increased service pressure, it unexpectedly stimulated expectations such as the Prosper Macao Plan. After the 1966 "December 3 Incident," government control weakened, and freer urban development produced new population attraction. After 1974, orderly regional autonomy and cooperation between government and Chinese associations enabled more regulated population growth.

Today political fluctuation no longer appears in the same form, but population change with new characteristics is reshaping the trajectory of urban development. Examples include population shifts from surrounding cities during the pandemic and structural population changes in older districts caused by delayed renewal. These changes reflect transformations in land value and business formats and are also embodied in the full-time carrying capacity of public service facilities[68]. During the day, facilities serve local residents; at night, they become social spaces for non-local workers. New population dynamics create demands for compound land use and generate governance challenges such as community integration, becoming a key dimension of resilient development.

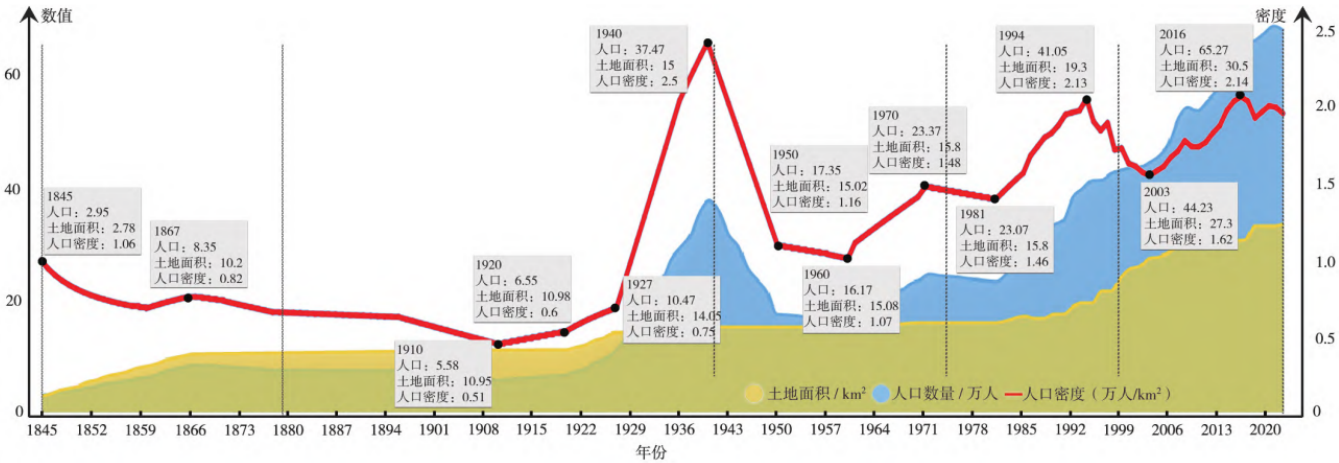


Fig. 3 The trend of population density in Macao

3.2 Land expansion as the trajectory of urban fabric evolution

The evolution of the urban fabric shows Macao's development path: an old-city core, land reclamation, and road extension. The third period had the broadest urbanized area; the fourth period shifted to infill construction; and the fifth period produced a more diversified urban appearance. After the road network took shape in the first two periods, it continued to improve. It accelerated urban expansion while also becoming a constraint on spatial growth[32].

Land scarcity was not always present in Macao's development. Population-density data (Fig. 3) show that the relationship between people and land shifted from relative harmony to conflict, but severe imbalance emerged when population growth far exceeded land supply. Macao experienced three historical peaks in population density, all of which highlighted the inability of land resources in specific periods to meet urban development and residents' living needs.

Although land reclamation eased the contradiction between land supply and demand, a development model based solely on outward expansion is unsustainable. Macao should shift from outward expansion to inward comprehensive use, increasing the use value and overall benefit of existing land.

3.3 Safeguarding development through the authority of legal norms

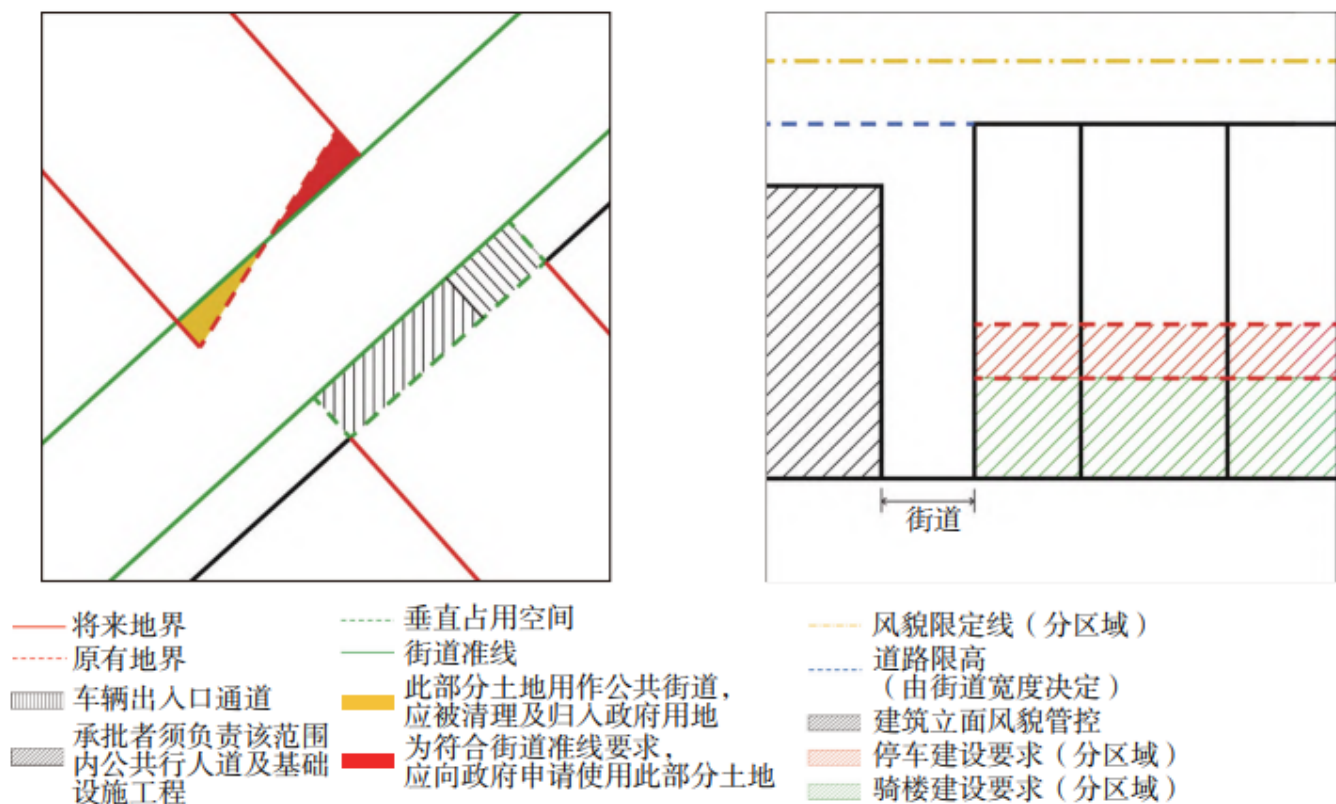
The application of the Portuguese Civil Code in 1879 was a critical turning point in Macao's development and is especially evident in the change in the degree to which affairs were lacking (Fig. 2). Governance shifted from the absence of systematic affair management to a framework and affair-processing paradigm driven by the civil code and planning ideas. Despite social turbulence, the increasing completeness and authority of regulations gradually made urban-affair control more comprehensive and professional, and its scope expanded significantly.

Authoritative regulations not only clarified the prospects for urban development but also effectively preserved the block pattern and architectural character of old districts (Fig. 4). The government also strengthened public awareness through multiple channels and improved governance effectiveness. Regulations must also consider the coordination among different laws to ensure harmony within the legal system. Only in this way can problems such as the withdrawal of the old-district redevelopment regulations^⑦ be avoided.

3.4 Architectural foundations and the shift in urban construction objectives

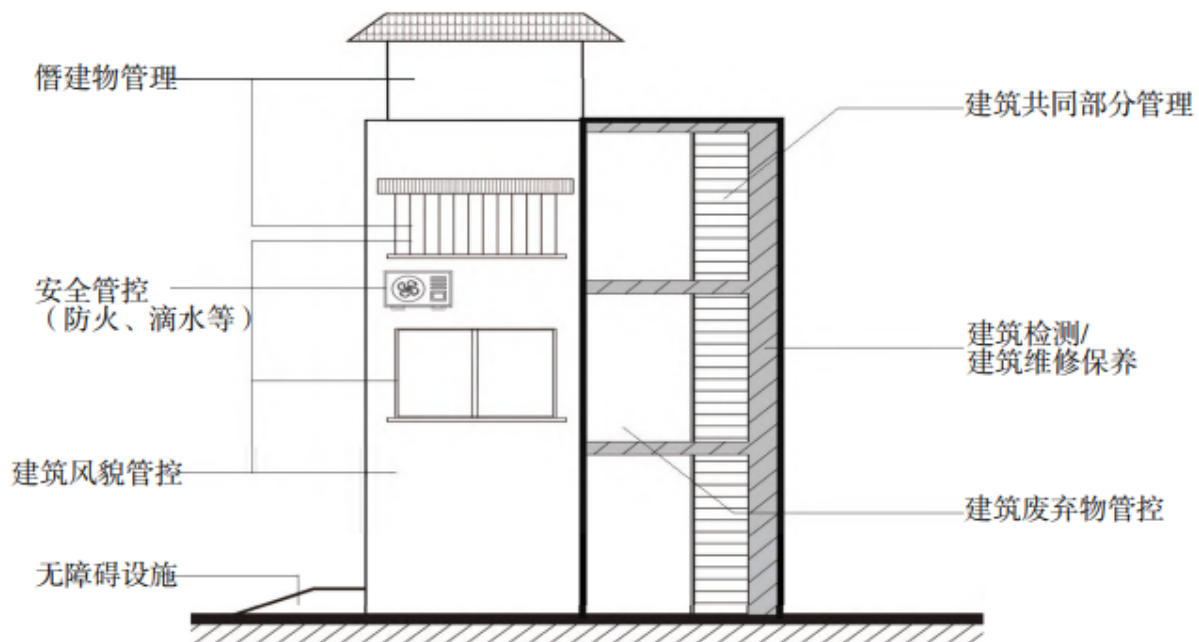
Macao's construction exhibits development characteristics at the levels of buildings, blocks, and regions (Fig. 2). The building level reached its peak earliest and has always remained central, continuing to improve in the fourth and fifth periods. The regional level dominated in the middle period, while the block level grew rapidly in the later period. This building-based development model is embodied in comprehensive and strict building-control measures under regional differentiation (Fig. 4), such as the management of unauthorized structures^⑧, the designation of buffer zones for historic districts, and building height control zones[69-70]. During building renewal and reconstruction, projects must not only be strictly supervised by the Land and Public Works Bureau and other departments; some must also seek opinions from cultural authorities, and cross-departmental cooperation increases project complexity[70].

Block revitalization and regional optimization have gradually become research focuses and face multidimensional and compound demands for improvement, yet both remain constrained by existing buildings. Strict construction control can provide a stable foundation for later development, but excessive comprehensiveness can also obstruct development. Although construction priorities have shifted over time, the foundational role of architecture must still be recognized, enabling the regeneration of spatial value under constrained development.



(a) 街道准线图

(b) 建筑立面控制线



(c) 其他管控措施

Fig. 4 Multi-faceted control during property development

3.5 Quality improvement and optimization of the existing urban environment

Statistical analysis of affair trends by stage (Table 1) shows clear differences in the focus of each development stage. Development priorities shifted from political system and land affairs concentrated in the first and second periods to planning-led priorities in later periods, with planning affairs reaching their peak in the fifth period. The evolution of affair trends confirms Macao's refined transformation. Residents' needs extended from basic housing to public service facilities and public spaces. Parking demand is also reflected in the increased attention to internal transport in the fourth and fifth periods. In addition, the growing attention to public health and disaster prevention indicates increasing concern for environmental beautification and safety during construction.

Table 1 Top eight single affairs by stage

Stage	1st	2nd	3rd	4th	5th	6th	7th	8th
Stage 1	Political system 9.51%	Land 8.54%	Population 7.77%	Housing 7.38%	Commerce 6.99%	Internal transport 6.99%	Geographical environment 6.60%	Planning 6.21%
Stage 2	Political system 9.41%	Planning 9.05%	Land 8.74%	Housing 7.30%	Geographical environment 6.84%	Public health and disaster prevention 6.84%	Internal transport 6.02%	Taxation and funding 5.35%
Stage 3	Planning 8.71%	Political system 8.10%	Land 7.86%	Housing 6.77%	Geographical environment 6.05%	Public health and disaster prevention 6.05%	Regulations 5.32%	Supervision 5.32%
Stage 4	Planning 9.85%	Land 8.32%	Public health and disaster prevention 7.00%	Housing 6.75%	Geographical environment 6.13%	Regulations 5.99%	Internal transport 5.20%	Taxation and funding 5.88%
Stage 5	Planning 10.75%	Internal transport 7.68%	Public services 6.82%	Public space 6.59%	Public health and disaster prevention 6.19%	Regulations 5.99%	Land 5.93%	Housing 5.62%

Land contradictions are especially prominent among composite affairs. Improving the quality of existing land - that is, implementing urban renewal strategies - has become one of the optimal paths for resolution. In Macao's future development, renewal strategies should be actively adopted to activate inefficient land, blocks, and buildings, and to respond precisely to the development needs of different areas. Drawing on the foundations of the first four stages and the affair ranking of the fifth stage, planning, transport, public service facilities, public space, public health and disaster prevention, and housing should be taken as key considerations for renewal and optimization.

3.6 Demand insight and the forward-looking nature of planning ideas

Throughout Macao's development, the expression of demand has run through government, society, and public participation in the supervision of urban development. Different actors have promoted development in different ways. The government has assumed responsibilities ranging from environmental governance in the Portuguese Macao period to infrastructure optimization today; merchants have provided necessary financial support in the pursuit of profit; and the public has used feedback mechanisms to identify and correct deviations

in development. These multi-actor, multi-dimensional participation mechanisms form Macao's distinctive urban development model.

A comprehensive review of Macao's affairs shows that precise demand insight and close cooperation among professionals fully demonstrate the forward-looking nature of modern planning ideas. This is reflected not only in several regional renewal control decisions in 1882 that resemble today's practices, but also in the government's timely adoption of social housing and disinfection measures to address housing and epidemic-prevention needs during periods of population surge (Fig. 3). The planning and action philosophy of accurately perceiving demand and quickly implementing measures has now been replaced in appearance by external experience, producing an impression of lagging planning and a disordered system. At root, however, this stems from a ruptured understanding of local historical experience and a neglect of Macao's own development trajectory.

The phased reclamation plan proposed in 1924 is almost identical to Macao's current form. It reveals planners' detailed investigation of existing conditions and expectations for future development, and to some extent proves that Macao once nurtured core planning ideas suited to its own needs. Macao urgently needs to absorb external experience while also re-examining itself, organically integrating history and modernity to construct a sustainable development path of its own.

4 Experience summary and prospects for Macao's urban development

4.1 Volatility generates urban breakthroughs

Macao's development history shows that volatility often breeds opportunities for breakthrough. Whenever the city encountered social turbulence or economic constraints, it was able to use these shocks to achieve leapfrog progress and move to a higher level of development. The key lies in accepting volatility with an open and inclusive attitude, accumulating experience through active trial and error rather than adhering rigidly to established models. This exploratory spirit enabled Macao to open a distinctive development path under multiple constraints.

Historical experience shows that Macao possesses a sensitive crisis-response mechanism. In the face of volatility, the government could quickly construct policy frameworks, guide the direction of change through regulatory improvement, and prevent risks. Precise response mechanisms once helped Macao open up several emerging fields of development. In recent years, however, lengthening policy-approval procedures have weakened the effectiveness of this formerly efficient mechanism. Government and professionals must keenly perceive fluctuations and handle development details and problems in a timely and efficient manner to support urban development.

In today's intensely competitive urban environment, overly cautious strategies are ill-suited to change. Only by maintaining institutional flexibility and balancing risk control with innovation vitality in dynamic adjustment can a city break through existing limits and achieve leapfrog development. This requires both the foresight of policymakers and the adaptive wisdom of the urban governance system.

4.2 Preventing contradictions from being deferred and solidified

Land issues severely constrain Macao's development[5]. The city has mainly used two strategies: land reclamation and optimization of land use. Reclamation has been regarded as the optimal solution for modern and contemporary development. Yet overreliance on reclamation has also delayed internal environmental optimization for a long time. Problems such as building inspection and infrastructure accumulated until they became difficult to reverse, leaving far fewer solution options and resulting in patterned responses. A single development path also weakened the diversity and flexibility of urban construction.

Contradictions should be prevented from being deferred. When problems first appear, measures should be taken proactively to resolve them rather than allowing them to accumulate and settle over time until they become chronic and difficult to overcome. Relevant issues must be addressed to avoid falling into fixed routines for solving urban problems. Professional assistance should be actively sought, and various contradictions should be resolved from multiple angles and levels in diverse and targeted ways, so that urban development quality can be comprehensively improved and the optimal development solution identified.

4.3 Improving regulations to guide development

The foundation of Macao's urban development lies in the coordination between advanced ideas and a sound regulatory system. Regulations, as a cornerstone of the city, provide a normative framework for development, but excessive constraints may restrict innovation. In Macao's old districts, for example, strict regulations have effectively preserved historical character while also limiting renewal in surrounding areas.

Urban construction therefore needs to seek a balance between norms and flexibility. It should use regulations to safeguard development order while retaining flexible space for distinctive urban creation. This dynamic balance has three aspects. First, regulations should set basic frameworks and avoid excessive detail that limits diversity. Second, implementation should include feedback mechanisms, adjusting details according to actual development. Third, public participation should create a supervisory loop, allowing regulatory improvement and urban renewal to interact positively. This model of "framework constraints plus flexible implementation" can both protect urban cultural continuity and stimulate innovative potential, ultimately creating positive interaction between urban development and regulatory improvement.

4.4 Focusing on the limiting poles of construction

In urban construction, strengths and areas of improvement often form the foundation of development. Yet foundations can also become the greatest limiting poles. In Macao, the limiting pole of urban construction is precisely the building level, which started early and developed a complete regulatory framework. It has become a rigid framework for development at the regional and block levels. Although limiting poles constrain urban expansion, they also provide planning scholars with a challenging question: how to activate urban potential within an existing framework.

A limiting pole is both a measure of development boundaries and a frame of reference for innovation. When a city is forced to engage with its limiting poles, multidimensional innovation solutions often emerge. Through three-dimensional space development and compound functional use, limited spatial value can be enhanced, pushing the city toward a more intensive and intelligent path.

4.5 The refined evolution of demand

Macao's modern and contemporary urban development has undergone a marked shift from government-led development to resident-demand orientation. This transformation is reflected not only in changes in land-use strategy but also in the steady improvement of urban quality: from early reclamation expansion that broke the bottleneck of land resources to the refined improvement of internal space and the creation of human-centered urban environments.

As demand becomes increasingly refined, the government's role shifts from sole decision-maker to demand coordinator. It must enter communities, approach everyday life, and accurately grasp residents' actual needs. In the renewal of the San Kio district, for example, planners helped translate residents' demands into professional language and communicate them to the government, forming operable policy recommendations. Through the path of "demand orientation - professional translation - policy implementation," optimization routes can be

selected that best match both residents' needs and actual urban development, thereby realizing harmonious coexistence between the city and its residents.

4.6 Phased forward-looking planning

Forward-looking planning ideas have been particularly prominent in Macao's urban development. Although they were difficult to fully understand at the time, phased planning and implementation gradually improved the overall layout of urban development. Phased implementation allows society and government to quickly observe results, avoiding disappointment, loss of trust, and divergent objectives caused by long cycles. It also facilitates timely correction and flexible adjustment of development direction, ensuring scientific and sustainable progress.

A phased prospective planning model can also ease funding pressure, strengthen the overall coordination of urban development funds, and enable efficient and rational capital circulation.

5 Conclusion

This paper analyzes scholarly research on Macao's modern and contemporary urban development from multiple perspectives, including political systems, urban space, urban construction, and planning ideas. It finds that although scholars have noticed the influence of external ideas on modern Macao planning, this influence has not been reflected in the division of urban development stages. Existing differentiated periodizations also fail to accurately present Macao's distinctive characteristics and internal logic in different historical periods.

The introduction of the theme-river diagram effectively reveals the development trends of urban affairs and identifies the different stages of urban development. Macao's modern and contemporary urban development can be divided into five periods: the implementation of colonial rule, the consolidation of colonial rule, the neutral-zone development period, the period of high regional autonomy, and the new era of "One Country, Two Systems." This division clarifies the internal logic of Macao's development, highlights the foundational role of the Portuguese planning system after its transplantation into Macao, and corrects the common scholarly bias that treats the 1911 occupation of Coloane or the 1912 Macao General Plan as the main stage-dividing node.

From six dimensions - population, land, regulations, buildings, environment, and demand - the paper describes modern and contemporary Macao's urban development and finds that population change reflects political fluctuation; land expansion records the evolution of urban fabric; the authority of legal norms safeguards orderly urban development; urban objectives shifted from individual buildings to regional integration; the quality of the existing environment has continuously improved; and forward-looking planning based on demand insight has run through the entire process. On the basis of these development logics, the paper summarizes several experiences: volatility generates urban breakthroughs; contradictions should be prevented from being deferred and solidified; regulations should be improved to guide development; limiting poles of construction should be recognized; demand evolves toward refinement; and phased forward-looking planning is essential. These experiences not only support Macao's own sustainable development but also offer reference and inspiration for other cities seeking development opportunities amid turbulence.

This study also has limitations. Theme-river analysis relies on large volumes of accurate data, and the absence of records for some years inevitably affects data precision and the accurate grasp of urban development laws. At the same time, clear and detailed classification of urban affairs is crucial to the theme-river method. Future research may use artificial intelligence to further improve the classification system for composite urban affairs, so as to more comprehensively grasp urban development trajectories and provide stronger theoretical support for urban development studies.

Notes

- ① This refers to the economic stagnation in Macao under U.S. trade controls in the 1950s.
- ② Impervious surface refers to land covered by impermeable materials and is one of the most prominent indicators of urbanization.
- ③ Sa Zhi Qi is a unique form of private contract in Macao involving land and housing transactions. It served as proof of folk land transactions in the Qing dynasty and earlier and is a distinctive historical legacy issue in Macao.
- ④ Urban renewal was formerly called "old-district redevelopment" or "block revitalization" in Macao and is now called "urban renewal."
- ⑤ Relevant historical materials also include events in Macao Memory and policy regulations of the Macao Printing Bureau.
- ⑥ During the Portuguese Macao government period, "public health" referred not only to epidemic prevention and medical care, but also to public sanitation management and municipal affairs, that is, urban cleanliness.
- ⑦ This refers to the withdrawal in 2013 of the Legal Regime for Old District Redevelopment because it was not properly coordinated with the Land Law, Urban Planning Law, Cultural Heritage Protection Law, and other regulations.
- ⑧ In Macao and Hong Kong, unauthorized buildings are called "illegal structures" or "unauthorized structures," including added canopies and balcony extensions.

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