Analysis of the Morphological Characteristics of Canton Postal Architectural Layout from 1842 to 1949 on GIS

Liu Qiong-Lin¹*, Liu Zhi-Ping², Chen Si-Yi³

¹School of Art and Design, Guangdong University of Finance and Economics, Guangzhou City, 510320, People's Republic of China.  
²School of Electronics and Information Engineering, South China University of Technology, Guangzhou City, 510641, People's Republic of China.  
³Queen Anne’s School, 6 Henley Road, Caversham, Reading, Berkshire, RG4 6DX, England.  
*Corresponding author’s e-mail: L@gdufe.cn

Abstract. Based on related research of typology, this research used GIS technology to analyze the spatial layout of postal buildings in Guangzhou from 1842 to 1949, and explored the spatial genetic characteristics of their waterfront space, location, system, etc. in the urban trade pattern space, which provided useful suggestions for the survival and regeneration of historical spatial context in the rapid urbanization of the post-industrial era.

1. Introduction

"Spatial Gene" is a unique and relatively stable spatial combination pattern formed by the long-term interaction and evolution of urban space and natural environment, history and culture[1]. Canton (now known as Guangzhou) has a commercial and trade history for two thousand years, which experienced the ban on maritime trade in the early Qing Dynasty, Canton System in the late Qing Dynasty, and traditional city modernization, etc. It gradually implanted the elements of modern industrial civilization from the west, and transformed itself from a provincial city of "Triple Walls" in the late Qing Dynasty into the first modern city in the Republic of China[2]. A large number of modern new-style commercial buildings, for example foreign firms, hotels, department stores, etc. that emerged in this city. They had formed a modern commercial pattern in this city together with the traditional buildings such as shopping malls and residential buildings. Among them, postal buildings were carriers that supported and promoted the development of modern postal services, and also it is a part of the natural growth of the commercial and trade pattern of modern Canton City. What are the characteristics of the "spatial genes" of these postal buildings? What was the relationship between them and the city’s commercial and trade pattern? This research will explore the interaction between the “spatial genes” of modern postal architecture and the development pattern of urban commerce and trade through the analysis of postal building layout and form features, and it maybe to provide a useful reference for the survival and regeneration of the historical spatial context under the rapid urbanization in the post-industrial era.

Canton is the birthplace of China modern postal service, the “Post Services Abroad”, and the
birthplace of the first post office of the Qing Dynasty too, so Canton was the starting point of the modern Chinese postal space network, for which connected Chinese transportation and logistics network in Qing Dynasty. This network includes posts, railways, highways, coastal steamships, inland shipping and private Letter Bureaus, etc.. It also joined with the postal system of modern significance in the West to maintain and promote the development of Canton urban space with China and western business culture.

When scanning the keywords of “modern”, “postal”, and “architecture”, there are only 124 items can be found on the China Knowledge Network from 2000 to the present (Fig. 1). There are seven projects supported by the National Self-Study Fund. When scanning the keywords of "Canton Modern Post", there were only 75 items from 2001 to the present. There are only three projects supported by the National Natural Science Funds of China and two by the National Social Science Fund of China. The current research on modern Canton post service mostly focus on the textual research and review of postal services, but was no research on the impact on the modernization of the city. For example, Leng Dong’s research on Canton’s "post services abroad" in the 18th century[3], Ni Jun-ming’s overview of the post and telecommunications industry of modern Canton, and Zeng Fan-hua’s summary of the management and operation of Guangzhou’s postal industry during the Republic of China, etc., all of these documents provided useful reference for this paper. And the paper which was researched by Wang Zhe and Liu Ya-yuan on modern China postal space through multiple versions of postal maps has enlightened on the architectural development pattern of Canton city.

![Fig.1 Measurement and Visual Analysis of Annual Trends of Related Research Publications](image)

2. The development overview of postal buildings in modern Canton

Postal service refers to "posting letters and parcels, processing exchanges and issuing publications, etc." [4] Postal buildings refer to buildings that meet the above functions and functional requirements for office, warehousing and logistics. Because of the huge benefits brought by the east-west trade routes, more and more countries had invested in the development and utilization of this routes, and the postal service was one of the most important businesses. From the perspective of international comparison, the postal industry was the fastest growing industry in modern China.[5]

Chinese postal system had a profound changes after the Opium War (1842). The first was the emergence of "Post Services Abroad" of the west. The second was that the Imperial Maritime Customs Service had established Chinese modern postal service, which is the national post office of the Qing Dynasty. Thirdly, the original post system of the Qing Dynasty was gradually abandoned. The fourth was the growing number of non-governmental institutions such as the "Civil Credit Bureau" and "Qiaopi Bureau".

In the 19th century, the Comprador of the United States had established a mail place where they delivered and received mail at the Sixing Pavilion on Dash Street in the Thirteen Factories. In 1834, Chinese first western concept of "Post Services Abroad" was established in the British consulate in Canton (Fig. 2) by William John Napier, who was the British business supervisor. The post services was administered directly by British general post office in London. After the Opium War, more and more countries set up "Post Services Abroad" in Canton with the increasingly closer business and cultural exchanges between China and the West. For example, France and Germany opened their first post office in China respectively in 1901 and 1902. The number of "Post Services Abroad" institutions in China had reached more than 340 until 1918.
There are also "Post Services Abroad" buildings in Canton, such as the French Post Office at No. 12 Shamian South Street, the German Post Office at No. 58 Shamian South Street, and the British post office at No. 44 Shamian South Street.

China's Postal Service in the Qing Dynasty officially relied on "Post House" and "Delivery Station" to contact the central, local, and military forces. And the same time, the civilians relied on "Letter Bureaus" and other institutions to deliver letters. The Qing government set up the first national postal institution in Canton in 1896, the "Great Qing Post Office", which used the management methods of the postal system in capitalist countries, and which resulted from the adjustment of the western postal system and the Chinese society.

The early address of the "Great Qing Post Office" was located in a small room in the northeast corner of the Canton Customs House. In 1904, the Post Office constructed a separate government-office building in Canton. The building was destroyed by fire in 1912. In 1916, Kwong-tung (Now is Guangdong) Post General administration building (Fig. 3) was built in Xidi road, which designed by Arthur W. Purnell who was an Australian architect of Purnell & Paget. The Great Qing Post Office in Canton lasted for 14 years from its establishment in 1897 to the end in 1911.

During the Yongle period (AD 1403-1424), the Civil Credit Bureau appeared in Canton, and they had made a great development until the Qing Dynasty, for there were a total of 70 Civil Credit Bureaus in Canton in 1901. In the 1930s, the more influential Civil Credit Bureau in Canton were "Hong-yan" (1875) which located at No. 6 Rong-yang Street in the Thirteen Factories, and "Peng-xin" which located at No. 51 De-xing North Road, and "Fu-chang" which located at No. 32 Tong-wen Road. In the middle and late 19th century, the "Qiaopi Bureau" appeared in Canton. For example, the building of No. 50 East He-ping Road was the former site of Yongchang Lezhuang which established in the Qing Dynasty.

In 1901, Kwong-tung Province has formed a postal network connecting postal routes of postman, ships and trains to the whole country, and initially formed a postal system of the whole province. On January 1, 1912, the Republic of China was founded, and the Great Qing Post Office was officially reorganized into an independent general post office. As a result, the old Post Houses, Civil Credit Bureau, Post Services Abroad, Post offices of the Republic of China and other institutions coexisted and jointly undertook all the postal services.

During the period of the Beiyang Government (1912-1928), the postal service gradually developed into the state-operated industry with a complete system and orderly operation, and gradually replaced the traditional post system such as the Civil Credit Bureau, and canceled the "Postal Service Abroad" in China, and completed the transformation from a traditional communication institution to a modern one.

3. spatial genes of modern postal buildings in Canton

3.1 Analysis of principles and preparation
(1) The temporal and spatial scope of the study

In the process of referring to and comparing 27 city maps such as the Canton city maps in the late Qing Dynasty, the urban map measured by the Canton Public Affairs Bureau in 1926, and the "Detailed Maps of Streets in Canton City" in 1948, considering that the research period of this paper was from 1842 to 1949 in the city of Canton, the content of the city map would accumulate and enrich with time. At the same time, with the advancement of exploration technology and cartography technology, the map of the Republic of China had precise projection technology and accurate symbolic expression.

Therefore, the spatial scope of the research was based on the graph scope of the 《Detailed Maps of Streets in Canton City in 1948》. During this period, the spatial pattern of Canton's commercial and trade had formed into three major business districts. [6]One was the Shamian (as Shameen or Shamin) and Xidi (now West Yan-jiang Road) Foreign Business District, the second was the Up and Down 9th Ward Street (now Shangxiajiu Road) Traditional Business District, and the third was Wing Hon Road (now Beijing Road) Cultural and Entertainment Business District (Fig. 4).

![Fig. 4 The commercial and trade pattern of Canton city in 1948](image)

(2) Analytical Method

A geographic information system (GIS) refers to a technical system that collects, retains, manages, calculates, analyzes, and displays geographic data that is distributed in whole or part of the surface space with the support of computer software and hardware. The geographical location information of modern postal buildings was extracted from the space of Canton city to form a visual spatial organization pattern, and analyze their carriers and explicit features of spatial genes by Kernel Density Analysis.

(3) Analytical Elements

"Spatial genes" are related to spatial elements, such as axes, waterfront spaces, streets, courtyards, etc. These elements form different structures, textures, sequences and other characteristics in different cultural regions. This research selected the attributes of postal buildings including geographic location, construction time and postal type, by which try to explore the spatial genetic characteristics of the building's waterfront space, location, system and so on.

(4) Base Map
This research refers to and compares total 27 map copies of Canton city during 1842 to 1949, such as the map of the measurement of the urban area by the Canton Public Affairs Bureau in 1926, and the map of 《Details of Streets in Canton in 1948》. Considering that the map shows the more development information of Canton’s urban business pattern in this century. At the same time, with the advancement of exploration technology and cartography technology, the map of the Republic of China was superior in accurate projection and symbolic expression. So I selected the 《Details of Streets in Canton in 1948》 as the base map for the comparison between the business pattern of city and the layout of postal buildings.

3.2 Process
(1) Positioning of the geographic information by literatures. This research collected and checked the geographic information on the literature of a total numbers of 45 buildings during 1842-1949 through field investigations and literature readings, which including 13 Post Services Abroads, 3 the General Post Offices of Qing Dynasty, and 13 Civil Credit Bureaus, 6 Qiaopi Bureaus and 10 Chunghwa Post offices (Fig. 5).

(2) Georeferencing. Converted The high-definition PDF file of the 《Details of Streets in Canton in 1948》 into a TIF file which is suitable for GIS, and then registers this TIF file to the current map coordinate system by checking the control points such as Shamian Land, Haizhu Bridge and other geographic data.

(3) Import it to GIS platform. Create a file in the shapefile, input the attributes of the building points, manually mark the building location with 6.00 dots on the platform ArcGIS10.5 platform. And then input the construction time and name attributes of each coordinate point in the table to form a building information table. The size characteristics and orientation of the building are not considered.

(4) Kernel Density Analysis. Analyze the three characteristics of the waterfront space, location, and...
the system of the spatial distribution of buildings, and the main driving factors by the kernel density non-parameter estimation method. At the same time, comparatively observe the characteristics of the spatial relationship between the postal buildings in Canton and the city's commercial and trade pattern. (Fig. 6).

3.3 Characteristics of Spatial Genes

As can be seen from Fig. 7, the communication network of the Canton Postal System from 1842 to 1945 showed the following distribution characteristics at the spatial genes, the research will explore their interaction with the spatial pattern of commerce and trade from the perspective of terrain, rivers, transportation, history and culture.

(1) The layout of postal buildings was closely related to the waterfront space of the city

The distribution of building points on the map illustrates that the number of post buildings is significantly related to the distance from the river (Fig. 7). The distribution of the 45 buildings coincides with or is close to the Shamian and Xidi Foreign Business District, the Up and Down 9th Ward Street Traditional Business District, and Wing Hon Road Cultural and Entertainment Business District in the spatial pattern of Canton commerce and trade, which demonstrates the close relationship between modern postal service and commercial activities. As a whole, the darkest color of the kernel density in the map is located at the intersection of "Shamian and Xidi Foreign Business District" and "Up and Down 9th Ward Street Traditional Business District", which is also the area with the most frequent business activities and the most active postal business in modern Canton. For example, 13 points are distributed in the "Shamian and Xidi Foreign Business District", 7 points are located in the "Up and Down 9th Ward Street Traditional Business District", and only 2 are located in the "Wing Hon Road Cultural and Entertainment Business District". Others are scattered around the south bank of the Pearl River and near the city's Central Park.

After the Opium War, water transportation played an increasingly important role in supporting urban economy and life. In 1888, Zhang Zhidong, Governor of Canton and Kwong-tung Province, sent a request to the Qing government to build a long embankment on XIDI of Pearl River side. In 1914, the government built the west embankment along the river. In 1918, the wall of Canton city was demolished. In 1923, and Dashatou Airport was built and located along the river side. During this
process of the construction of new highways in modern Canton, the reform of waterway transportation was also started rapidly under the impetus of commercial activities. There are a number of private docks on the north bank of the Pearl River, such as there were more than 19 docks from Tian-zi Wharf to the north bank of Xidi in 1931.

"Shamian and Xidi Foreign Business District" and "Up and Down 9th Ward Street Traditional Business District" were the most dynamic and busiest urban areas in the city due to the open business activities. These business districts are close to the Pearl River waters, connecting the vast hinterland of the Pearl River, and the postal buildings serving the business activities are also tending to be set up on the Pearl River waterfront.

The postal buildings have the characteristics of tending to be distributed near the Pearl River waters, which shows that the postal buildings are much more dependent on water transportation than roads or other types of transportation. The waterfront space of the city has a significant correlation with the spatial distribution of postal buildings.

(2) The location of postal buildings has a growing trend toward where the three rivers intersection

This research analyzes the spatial distribution and aggregation characteristics of postal building points within the scope of analysis by the kernel density analysis function of ArcGIS 10.5, it is possible to determine building hot spots area. The kernel density analysis is a method that uses a kernel function to associate each known point in the research area for estimation, and the selected kernel function is Rosenblatt-Parzen function. The studies showed that the kernel function had very little influence on the results but great influence on bandwidth. At present, there is no authoritative formula for determining the bandwidth value, and the author had determined the bandwidth values to be 1.0 km and 1.2 km based on multiple experiments. (FIG. 8)

As shown in Figure 8, the distribution of postal buildings gradually decreases from the southwest of the city (near the Shamian and Xidi) to the north, and there is a significant tendency to gather at the intersection of three rivers. The spatial density of the postal buildings was extremely unevenly distributed, presenting two high-density areas, one is in the Shamian and Xidi Foreign Business District (5.552 ~ 6.478) and the other in the Up and Down 9th Ward Street Traditional Business District (7.403 ~ 8.329). In terms of distribution, it presents the "hot spot" area where large-scale postal gatherings gather and the "cold spot" area where small-scale postal gatherings gather. The former is located in Shamian and Xidi Foreign Business District, and the latter was located in Wing Hon Road Cultural and Entertainment Business District.

The central axis space of Canton city in the Qing Dynasty was the strip space from Han-min Road to Tian-zi Wharf. (Fig. 9) From 1918 to 1920, the municipal office of Kwong Chau Department demolished the city wall and built roads. Then the city boundary was broken by innovation forces, and it continued to grow under the driving force of commerce.

According to the figure 9, the postal buildings are not located on the central axis of the city, but are distributed in a free way with uncertain locations, which the Pearl River is the boundary and with more
north than south, and more west than east. The location of the building is characterized by clustering and distribution to the west along the intersection of the three rivers (Baiertan).

This phenomenon coincides with the trend of high-density aggregation and growth of commercial and trade buildings along the waterway in cities (Fig. 4). On the one side, it shows the important historical position of these geographical locations in the development history of Canton's modern commerce and trade. On the other side, it also shows that there is a large regional imbalance in the postal architecture of Canton.

(3) Coexistence of multiple systems

The characteristics of building system were divided into orthogonal system and non-orthogonal system. As shown in the 《Details of Streets in Canton in 1948》, the postal buildings in Canton from 1842 to 1949 had both types of systems.

The urban planning of Shamian Inland in Canton is an orthogonal system, and the "Post Services Abroad" buildings located here exist in an orthogonal form (Fig. 10). The Postal buildings which were inside and outside the ancient city of Canton grew according to the original urban spatial, maintaining a non-orthogonal system, such as the General Post Office of Qing Dynasty (Fig. 11). Although the two system forms coexist, the location of the Qing postal building is on the important position of the urban space, that mean this system has the main control power in the entire city postal system.

The "Post Services Abroad" was a diplomatic issue between the Qing government and western countries, and Great Qing Post Office could not interfere with the "Post Services Abroad". Great Qing Post Office followed the suggestion of Sir Robert Hart, that was "A variety of postal coexistence, with different measures to deal with their relationship". Then it was successfully achieved the adjustment of Western postal system and Chinese society.

4. Conclusions

This paper finds that the spatial genes of the postal buildings from 1842 to 1949 in Canton presents the following three characteristics based on GIS Data, one is a close spatial relationship with the urban waterfront, two is a growing trend toward where the three rivers intersection, third is coexistence of multiple systems.

Atlas analysis of scientific knowledge can effectively avoid research problems such as inability to deal with massive documents, time-consuming and labor-intensive. Therefore, GIS is a more scientific and efficient research method, compared with traditional academic history research methods.

The unity and uncertainty of the sample data make the analysis could not more detailed.

In the subsequent research, we will accumulate more information, strengthen the application of GIS, exert its powerful data analysis and spatial exploration functions, explore the genetic characteristics of urban space. Then we could provide useful suggestions for the survival and regeneration of the historical spatial context in the rapid urbanization in the post-industrial era.
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