IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 21, Issue 4. Ser. IV (April. 2019), PP 21-27
www.iosrjournals.org

Relationship between Urban Retail Commercial Space Distribution and the Road Network& Population Distribution: Comparison of Mobility and Non-Current Factors

Tianxiang Zheng
(Shenzhen Tourism College, Jinan University, China)
Corresponding Author: Tianxiang Zheng

Abstract: *The research on commercial space distribution generallybased on the spatial distribution of human. Traffic and itsmobilityplay an increasingly important role in business, exploring the relationshipbetweentraffic and commercial elements of the spatial pattern has greatsignificance. In thispaper, wecollected spatial data of 1628 commercial outlets in four types of commercial activities, includesupermarkets, department store, convenience stores, grocery stores in Tianhe District. Thenmake a kerneldensityanalysisseparately for different commercial activitiesusingArcGIS. On this basis, analysize the correlation of traffic, population and different commercial activities, compare the degreebetweenthesetwofactorsassociatedwith the distribution of retailoutlets in Tianhe District. Our conclusions are as follows: (1) For the overall or differentkinds of retail business, kerneldensityanalysiswithtraffic and population showed a correlation, trafficishigherthan the degree of the population. (2) There are differentrelationshipbetweentraffic and types of retail business, convenience store most relevant, the othersshowed a weakcorrelation, correlationbetween population density and different types of retail business issimilarwithtraffic. (3) Influence degree of traffic and population betweenconvenience stores and grocery stores are similar, for supermarkets and department stores, and trafficfactorsobviouslyplays a more important rolethan population. (4) Retail commercial space structure in Tianhe district usedtraffic network as the backbone, presented in a linear and punctiform spatial distribution based on traffic network, features of the retail commercial space in Tianhe District canbe more intuitive understood in the perspective of traffic.*

Keywords: *Transportation network, Population, Commercial outlets, Kernel density, Scale*

Date of Submission: 02-04-2019 Date of acceptance: 17-04-2019

I. Introduction

Retail outlets as an important object of study of commercial geographic space, people have a long time to study the characteristics of commercial space. Traditional urban commercial outlets regard the general consumer who in the vicinity as a target, so the structure of commercial space is directly linked to density of population. Therefore,related research is also based on perspective of the spatial distribution of human to the analysis spatial distribution of business.Study of the spatial structure of Western business can be traced to the traditional location theory and the center theory, near the opportunity to emphasize the consumers, economic activities outlets et al.[1]Early domestic retail commercial space structure often used big cities as cases , used central place theory to verify hierarchical and center of commercial facilities[2-4]. Since the measurement of the revolutionary in 1960s, the school of spatial analysis has become an important method of study the commercial space structure, it is still used population as the basis of its models, such as "Retail Gravity Model"[5]. Huff's "probability model"[6],Berry's "three activity theory"[7]and David's "shopping center hierarchy system development model"[8] spatial analysis of domestic commercial geography also showed similar characteristics[9-11].On the affected of Behavior Theory and the humanistic school, related research of the commercial space structure began to study the effect of consumer behavior differences to the business spatial structure.Likethe study of GuoWenbo[12],Wang De[13],Zhou Suhong[14], previous studies on the spatial structure of urban commercial network, seldom directly took into account the relationship between traffic flow and commercial space structures.

With the exponentially growing rapidly development of transport, people, logistics volume. Traffic elements, together with the mobility of its generated in economic activity, especially in business, play an increasingly important role. Overseas scholars began to attach importance to the relationship between the flow path and commerce.Porta used Bologna of Italy as a case tofind that the advantages of the location within the city is not near with kinds of opportunities (including consumers, economic activity outlets, etc.) as the traditional location theory emphasized, but the "crossing point" of these opportunities interrelated need to walk

through[15]. Timothée used Kernel Density Estimator analysis road network in Barcelona of Spain to find that there is a strong link between the density of the road network and economic activity[16].As such, intensity of urban land use (such as density of commercial and service outlets) is closely linked with the road network. Distribution and structure of the road network within the city determines geographical features of the points (such as its road network nodes), which determines the intensity of land[17].Research by Wang Fahui and Baton Rouge (Louisiana) of United States are also found that interpretation center which based on the road network for the explantion of population and employment density distribution is far superior to the traditional economic model[18].Ko-Wan Tsou through analysis retail impact of the road network facilities and the public transport network in Taipei, Taiwan, found that both the impacts on the retail business existed[19].

Transport medium, played an increasingly important role in the development of urban economy and retail commercial space structures, but researches based on transportation media for commercial space distribution domestic is still rare.For example, Chen zhongnuan studies the impacts that rail transit for construction of urban commercial space[20]. Deng zhongweifound that the spatial distribution of taxis in Shanghai has a high positive correlation with the downtown business district[21]. However, these studies did not compare the intensity of traffic and population structure of the degree of influence on the retail business, or just a qualitative analysis of the causes of commercial space structure[22].Therefore,this study usesTianhe District of Guangzhou as a case,to apply network analysis commercial of spatial distribution toTianhe District and make a comparative analysis between transportation media and the population(consumers) with strength of the business spatial pattern.

II. Study area and data sources

2.1 Study area

Tianhe District, located in the eastern part of the urban area of Guangzhou, Guangdong Province, administered Chebei, Wushan, Yuancun and other 18 streets. GDP (gross regional product) of Tianhe District in 2012 is 239.481 billion yuan, ranked first in the city districts(county-level cities) in GDP, the total retail sales of social consumer goods, per capita consumption expenditure of urban residents and other indicators[1]. Tianhe district is the new city center of Guangzhou, one of China's most developed commercial center, the northeast part of the district has extended to the suburbs[2]. Therefore, takingTianheas a case, we analyze differences that spatial changes of traffic and population affect the special structure of retail commercial types.

2.2 Data Sources

Refering to Xiaopei Yan, Geng Lin and other scholar's standards about spatial structure of retail commerce, it could be divided into seven categories. Three kinds of commercial activities are excluded for there are largely influenced by special locational factor. This paper selected four kinds of commercial activities, namely, supermarket, department store, convenience store and grocery store, which both have strong comparability and closely associated with urban traffic, stream of people, distribution of the population(Table 1). By using google, AMAP and other network map tools, it's enough to search spatial location and name of supermarket, department store and clothing specialty store, then new GIS database is established, vectorizing the main forms of spatial position. By field survey and commercial outlets location of retail commerce provided by Google map, the total number of retail outlets are 1628(Figure 1).

Tab.1 The attribute table of kind of the retail business

Names of the formats	Attribute
department store	Shopping malls or shopping center, which is made up of multiple rental, including commercial catering entertainment and other service facilities
supermarket	Large, medium, small supermarket, packaged food, fresh food and commodity markets
convenience store	Instant food, Daily necessities and newspapers are given priority to, such as convenience store, chain store, newspapers and magazines, etc
grocery store	Food satisfy daily life is given priority to, such as meat market bakery, etc

There is a certain error for using Kernel density function analysis assess research marginal area business. To increase the accuracy of analysis, data used in this paper including Tianhe district edges street. The data of population mainly comes from guangzhou tianhe district population statistical information network, and the date of road network comes from vectorized Google map(Figure 1).

[1]Sources,Tianhe Statistics Information Network.http://tj.thnet.gov.cn/v2008/thgk/

[2]Source,Tianhe Information Network.http://www.thnet.gov.cn/zjth/thgk/zrdl/200611/t20061114_93886.html

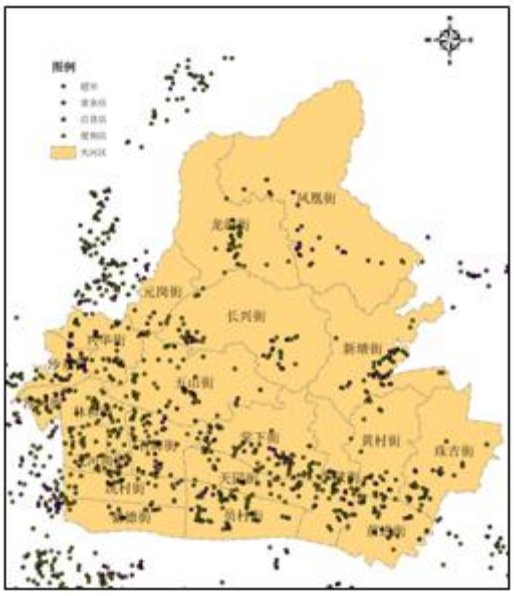

Figure 1 Study area in Tianhe,Guangzhou

III. Methodology

To analyze the differences of spatial effects of which the spatial variation of traffic and population on the different commercial activities in Tianhe District, Guangzhou, in this paper, on the basis of collected data and ArcGIS, we use kernel density analysis method, the distribution density of retail commerce to overlay with traffic network and to explore the spacial distribution of retail commerce in Tianhe District. Getting the population density by Kriging Interpolation of street population in 2010 of Tianhe District, the density of traffic network and various categories of retail commerce by kernel density analysis is divided into grid of 500 × 500. We then compare the effect of traffic and population factor on commercial distribution, through the correlation analysis of grid values.

Kernel density estimation is a kind of nonparametric density estimation. Through the kernel density estimation, we can extend information from the location to the district. Kernel density estimation can be often used to help to identify traffic accident areas, animal habitats, and hot spots of diseases, etc. There are different possible kernel density estimations of functional form, in this paper we will draw the method for my study:

$$f(x)=\frac{1}{h}\sum_{i=1}^{n} w_i k(\frac{x-X_i}{h}) \quad (1)$$

In equation (1): where h represents bandwidth or smoothing parameter;n represents the observed sample size;W represents the weight of location i, and we set W =1 in this paper;x represents the value of the estimated location, $X_i$represents the observed value of i;the function of K(x) showed in equation (2):

$$K(x)=\begin{cases}3\pi^{-1}(1-x^T x)^2, x^T x\le 1\\ 0, otherwise\end{cases} \quad (2)$$

Kernel function estimation can be calculated by kernel density in ArcGIS, then the results is divided into 8 grades using the nature break. The deeper color represents the greater commercial density (Figure 2).

IV. Findings

4.1 Comparison of influence degree that effects between density of traffic network and population on retail distribution in Tianhe District

For better comparison of correlation degree, we use the kernel density analysis to obtain the density of traffic network and various categories of retail business, and then divide this area into grid of 500 × 500m. On the basis of the above, we compare the influence degree that effects between density of traffic network and population on retail distribution through the correlation analysis of grid values. Using Person correlation coefficient and Spearman correlation coefficient, wecalculate the correlation between density of traffic network and population and density of retail outlets(Table 2). The Person correlation coefficient between population density and the density of retail outlets is 0.485, significance level $p<0.01$; the Person correlation coefficient between traffic network density and density of retail outlets is 0.540, $p<0.01$. As a consequence, the density of population and traffic network and retail outlets density are significantly correlated in Tianhe District, the traffic

network density is more relevant to retail outlets density. Similarly, the Spearman correlation coefficient between population density and the density of retail outlets is 0.582, significance level $p<0.01$; the Person correlation coefficient between traffic network density and density of retail outlets is 0.662, $p<0.01$. As a consequence, the density of population and traffic network and retail outlets density are highly significantly correlated in Tianhe District, the traffic network density is more relevant to retail outlets density.

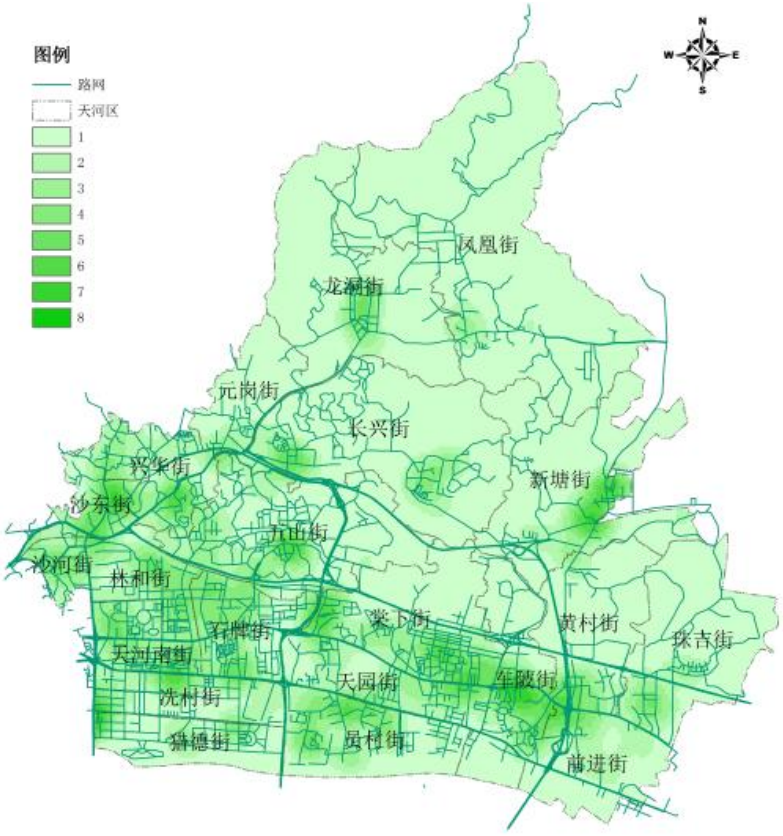

Fig.2 The Tianhe retail distribution base on road network

Tab.2 comparison with population and retail density correlation, traffic and retail density correlation

	Traffic network	population
Pearson correlation coefficient	0.540**	0.485**
Spearman correlation coefficient	0.662**	0.582**

Note: **represents a significant correlation at the 0.01 level (bilateral)

Through cross-examination of Person and Spearman correlation coefficients, we can draw that traffic network density is more relevant to density of retail outlets than the population density. Traditional spatial distribution of retail commerce is close to the markets with more consumers. Retail outlets intensity and population density distribution is a positive correlation in Guangzhou, and the distribution of commercial network and population distribution is basically consistent, and the areas with dense population is also the areas with dense and intensive commercial outlets. However, in this case, traffic condition is a more important decision factor to commercial network development in Tianhe District, Guangzhou. Commercial outlets should have the superiority of geographic location to become a commodity distribution center, and to facilitate the sale of goods, hence the traffic conditions have higher requirements. Well-developed transportation network provides the basis for the exchange of business flow, material flow and information flow. For retail outlets, excellent transportation environment provides a strong external condition for its business expansion and optimization of business structure. Meanwhile, the expansion of business will attract large numbers of people poured into the district and promote further development of transportation.

4.2 Comparative analysis of the correlation of different categories of retail and density of traffic network and population

This study reveals that the spatial distribution of the retail has a close relationship with the traffic network density, and a certain correlation with distribution of the population. In order to further consider

whether there are differences between the spatial distribution of different kinds of retail to the density of traffic network and population, retail stores can be divided into supermarkets, grocery stores, convenience stores and department stores based on collected commercial data, and calculate spatial density of various retail stores using the grid of 500 × 500m for the spatial unit, then make the Pearson correlation analysis with the density of traffic network and population respectively, as shown in Table 3:

Tab.3 comparison on population and kinds of retail density correlation, traffic and kinds of retail density correlation

Retail type	Traffic network	Population
Supermarkets	0.350**	0.297**
grocery stores	0.265**	0.262**
convenience stores	0.529**	0.518**
department stores	0.299**	0.179**

Note: ** represents a significant correlation at the 0.01 level (bilateral)

Table 3 shows that the density of the traffic network and the supermarkets has an average correlation ($r = 0.350$, $p<0.01$); grocery stores density and the density of the traffic network showed a weaker correlation ($r = 0.265$, $p<0.01$) in the 0.000 confidence level; convenience stores density and the density of the traffic network showed a higher correlation ($r = 0.529$, $p<0.01$); whereas department stores density and the density of the traffic network has a weak correlation ($r = 0.299$, $p<0.01$). Similarly, the correlation analysis of different types of retail density and population density can be through the test in the same high level of confidence. Except that convenience stores density and the density of the traffic network showed a higher correlation($r = 0.518$, $p<0.01$), other types of retail and the population density showed a weak correlation (r=0.297, 0.262, 0.197 respectively for supermarkets, grocery stores and department stores).

Department stores and supermarkets showed a weak correlation with density of transport and population, whereas the effect of transportation is significantly greater than population, which is due to that department stores and supermarkets sell a broad range of goods, possess a huge store area, and often locate in the greater convenient traffic with strong accessibility and convenient parking for car and a more open space, where population have less impact on department stores and supermarkets.

Traffic and population have a concordant degree of influence on convenience store and grocery stores. Convenience store distribution and the density of the traffic and population both showed a high correlation and a small difference. Transportation and population both are important factors affecting the spatial distribution of the convenience store and their degree of influence is similar (see Table 3). This closely relates to the commodity type that convenience stores sell and their size. Convenience stores suit to locate in where is convenient, crowded and with limited space such as the street corner, or close to residential areas. Grocery stores distribution and the density of traffic and population also showed a weak correlation and a small difference, traffic and population are both generally factors affect miscellaneous food shops distribution.

V. Discussion

5.1 Traffic flow and distribution of commercial space

Predecessors carried out relevant research on the correlation between traffic and commerce. Through the case study of Guangzhou,Yan Xiaopei found that there is a correlation between road network and commercial grade: the more dense road network, the higher the commercial grade would be[14]. By carrying out the regression analysis between type of business area of commercial center of Tokyo Station and Daily ridership of its adjacent station, Hubaoze found a very good correlation ($r = 0.949$) between these two. The higher the level of the commercial center, the greater its relevance. While the low level of commercial is low correlation with traffic and flow[25]. High level of retail commercial requires large-scale of population flow and more impression by traffic factor,by contrast of substandard retail commerce.

Comparison with previous studies, this paper's main contribution is the research the relationship between urban retail commercial space distribution and the road network, population distribution.The road network means mobility and the road network means non-current factors comparison.We find the density of the road network and population are all related to different types of retail business to some extent.The correlation population of them are similar,which means transportation and population are all the important factors that influence the distribution and structure of retail commercial space. But the correlations between each type of retail density and road density are slightly higher than the corresponding correlation format retail density and population density; Thus, we put forward to a view that with the world enter into a mobility society, traffic has become a factor beyond the population for retail distribution.

Meanwhile,supermarkets,department stores and other higher rank retail commerce affected by traffic factors far outweigh the impact of population factors (see Table 3). Both those kinds of retail commerce based on traffic flow, rather than a fixed source from the surrounding population. Retail trade, high-grade retail in

particular, separated from in particular and became tend to the traffic factor. With the development of transportation, transportation costs fell, urban mobility greatly enhanced, future retail location choice will be more reliance on traffic conditions rather than surrounding inhabitant factors. High-density urban development will become the mainstream tendency of urban plan and construction, the traditional region relied on regional center is replaced by a large-capacity, high-density traffic region. From this point, commercial structure study in terms of traffic mobility become much closer to the reality condition rather than population-based elements.

5.2 Retail spatial distribution based on the traffic spatial distribution, a better understanding of retail space of Tianhe District

In general terms, the retail spatial distribution of Tianhe District shows a characteristic of small scale centralized and disorder spatial distribution overall. But after overlay ofTianhe District road network, we can find it there is a big relationship between the spatial distribution of retail and the road network. Based on the Perspective of the road network, the whole space can be more clear understanding of the distribution of commerce in Tianhe District (see Figure 2):

1) The distribution of retail in Tianhe District presents a wide range of "linear distribution", along the main street, and the main road was linear distribution: mainly in Zhongshan Road, Huangpu Avenue to east-west axis; Guangzhou Avenue, Section Yun Road as the vertical axis.

2) On a small scale, the distribution of commerce based on the road network,showing "massive distribution" in a certain area. In the pedestrian street, such as Shi Pai Dong, Cave pedestrian street,Retail distribute along road network in massive cluster feature.

3) Due to traffic changes overall, the distribution of retail shows a decreasing trend from south-west to northeast.In Southwest area of Tianhe District, the center of Guangzhou,with good transport accessibility and large road network density, which will help attract people flow, promote the development of the retail industry, and ultimately contribute to the retail commercial center of Guangzhou.The East-north area in Tianhe District,with poor transportation accessibility and low road density,can't attract people flow as the south-west area,form lower retail outlets density finally.Transportation network provides people flow for the retail commerce, and ultimately promotes the formation of retail pattern in Tianhe District.

Finally, Chinese tap water is prone to secondary pollution while it is being delivered from the water facility to consumer taps. Piping used to deliver water in many cities are outdated and water can be polluted with contaminants in the piping while being transported. Inconsistent levels of chlorine in water treatment facilities also lead to bacteria buildup. Yu Xin, a scientist at the Chinese Academy of Sciences, found in his research that "not only have large colonies of bacteria been found in the nation's water pipes, but some otherwise harmless bacteria are becoming drug-resistant." This is likely due to the fact China currently only requires that each liter of tap water be treated with 0.05 mg of chlorine. The World Health Organization recommendation is 10 times that level and the US requires 40 times as much.

VI. Conclusion

We collected spatial data of four types of commercial activities, include supermarkets, department store, convenience stores, grocery stores in Tianhe District. Then make a kernel density analysis separately for different commercial activities using ArcGIS. On this basis, we analyze the correlation of traffic, population and different commercial activities and compare the degree between these two factors associated with the distribution of retail outlets in Tianhe District. Our conclusions are as follows:

(1)For the overall or different kinds of retail business, kernel density analysis with traffic and population showed a correlation, traffic is higher than the degree of the population.

(2)There are different relationship between traffic and types of retail business, convenience store most relevant, the others showed a weak correlation, correlation between population density and different types of retail business is similar with traffic.

(3)Influence degree of traffic and population between convenience stores and grocery stores are similar, for supermarkets and department stores, traffic factors are obvious plays a more important role than population.

(4) Retail commercial space structure in Tianhe district used traffic network as the backbone, presented in a linear and spatial distribution based on traffic network, features of the retail commercial space in Tianhe District can be more intuitive understood in the perspective of traffic.

Acknowledgements

The author expresseshis deep appreciation to Y.Q. Wang of the Sun Yat-sen University, for his technical assistance, helpfuldiscussions and valuable suggestions.

References

[1]. Berry B J L, Garrison W L. Recent developments of central place theory. *Papers in Regional Science*, 1958, 4(1): 107-120.
[2]. Ning Yuemin,An Approach to Shopping Center Location of Shanghai's Urban Area. *ActaGeographica Sinica*.1984,39(2):163-172.
[3]. An Chengmu, Analysis of Lanzhou Commercial Centre's Location Pattern and Advantage Degree. *Geographical Research*.1990, 9(1): 28-34.
[4]. Yang Wuyang,The Retailing and Service Center and Network of Beijing-then, now and long Before. *ActaGeographica Sinica*.1994, 49(1): 9-17.
[5]. Ming-long LEE, R. Kelley Pace. Spatial Distribution of Retail Sales. *The Journal of Real Estate Finance and Economics*. 2005, 31 (1):53–69.
[6]. Davies R L. *Marketing Geography: with special reference to retailing*. Methuen, London.1976:132.
[7]. Richard F. Lamb. The Morphology and Vitality of Business Districts in Upstate New York Villages.*Professional Geographer*. 1985,37(2):163-173.
[8]. Huff D L.A probability analysis of shopping center trade areas.*Land Economics*.1963(53):81-89.
[9]. Chen Zhongnuan, Chen Ying,GanQiaolin, etc.A probe into feature of commercial regional structure in KunMing city and adjustment strategies.*Human Geography*,1999, 14(4): 21-25.
[10]. XUE Juanjuan, ZHU Qing.Review and Prospects for Study on Spatial Structure of Urban Commerce.*Areal Research and Development*, 2005,24(05):21-24.
[11]. Zhang Shuiqing. Retail institution and their effect to urban commercial spatial structure.*Human Geography*.2002, 17(5): 36-40.
[12]. GuoWenbo,Zhang Yan,Chai Yanwei,Shen Yue. Study on spatio-temporal figure of suburban residents based on GPS data:a case of Tiantongyuan and Yizhuang in Bejing.*Areal Research and Development*.2013, 32(6).
[13]. Xu Zun, Wang De. Consumers'behavior and planning in commercial spaces, Shanghai Xintiandi example. *Planners*.2012, 28(1): 23-28.
[14]. ZHOU Suhong,LIN Geng,YAN Xiaopei. The relationship among consumer's travel behavior, Urban Commercial and Residential Spatial Structure in Guangzhou,China.*ActaGeographica Sinica*.2008, 63(4): 395-404.
[15]. Porta S, Latora V, Wang F, et al. Street centrality and densities of retail and services in Bologna, Italy. *Environment and Planning B: Planning and design*. 2009, 36(3): 450-465.
[16]. Timothée P, Nicolas L B, Emanuele S, et al. A network based kernel density estimator applied to Barcelona economic activities//*Computational Science and Its Applications–ICCSA 2010*. Springer Berlin Heidelberg, 2010:32-45.
[17]. Lin Hui, Lai Jinggui,Zhou Chenhu.*Spatially Integrated Humanities and Social Science Research*. Beijing: Science Press, 3-16.
[18]. Wang F, Antipova A, Porta S, Street centrality and land use intensity in Baton Rouge, Louisiana. *Journal of Transport Geography*, 2011, 19(2):285-293.
[19]. Tsou K W, Cheng H T, The effect of multiple urban network structures on retail patterns: A case study in Taipei, Taiwan. *Cities*, 2013, 32:13-23.
[20]. Chen Zhongnuan, Feng Yue, Jiang Jin, The Commercial Agglomeration and Influence Factors of nearby subway station.*Journal of South China Normal University(Natural Science Edition)*.2013.45(6)189-196.
[21]. Deng Zhongwei,Ji Minhe. Spatiotemporal distribution of taxi services in Shanghai.*Urban Transport of China*.2012, 10(1): 68-74.
[22]. Lin Geng, XU Xueqiang. Forming mechanism of spatial structure of commercial types in Guangzhou City.*ActaGeographicaSinica*.2004, 59(5)754-762.
[23]. Lin Geng, Ruibo.*Commercial Space Research in cities*. Commercial Press, 2008.
[24]. LI Chunming, WANG Yajun, LIU Yin, DONG Rencai, ZHAO Jingzhu. A study of the temporal-spatial behavior of tourist based on georeferenced photos.*Tourism Tribune*,2013, 28(10): 30-36.
[25]. Hu Baoze.*The retail commercial center in Tokyo*.TianJin:TianJin Press,2000.

IOSR Journal of Business and Management (IOSR-JBM) is UGC approved Journal with Sl. No. 4481, Journal no. 46879.

Tianxiang Zheng. " Relationship between urban retail commercial space distribution and the road network& population distribution: comparisonof mobility and non-current factors". IOSR Journal of Business and Management (IOSR-JBM), Vol. 21, No. 4, 2019, pp. -.21-27