

Analysis of factors Affecting the Development of Fast-Food Industry Based on Machine Learning Methods

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Abstract. Fast food industry is one of the fastest-growing businesses in the world. In this paper, we analyze the development situation of KFC in the Yangtze River delta area (Jiang Su, Zhe Jiang, and Shanghai). According to the analysis of specific data related to the distribution of shops and sales data, we aimed to create the proper strategy for its future development in this zone. We analyze the connection between the number of KFC shops and different classes of cities. We also analyze the relationship between population density and KFC shop distribution by a case. Especially, we use PCA (Principal component analysis) to find the most important influence factors, and the experimental results show that GDP, population with the unit of million, the output value of the second industry are the three key factors affecting the number of KFC outlets. Finally, we analyze the typical features of the Yangtze River delta area.

Keywords: Principal component analysis; sinking market.

1. Introduction

As the economy booms and the social pace speeds up, more and more people choose fast food as their daily food. For example, KFC and MacDonald are popular over the world. Now in China, KFC has more than 6000 restaurants in cities and countryside and creates substantial employment opportunities for Chinese citizens with fostering the development of the Chinese economy to a large degree. So, it is meaningful for us to do some research in the fast-food industry, which can increase sales of fast-food companies, create more profits and help the enterprise with reasonable development planning.

Now, many researchers have carried on many pieces of research on the fast-food field. For example, Lee et al. investigated satisfaction factors of service, food, and price affecting general satisfaction factor, they also assessed how general satisfaction factor affect the brand preference for fast food restaurant customers [1]. S Oranusi et al. investigated the microbial quality of snacks (ready-to-eat foods) sold in Ota, Ogun state [2]. A total of 100 different samples from 3 vending sites namely, a university cafeteria, a top-class snacks bar, and a local kiosk were analysed for total aerobic plate count, coliform count, and for specific pathogens and fungi. MK Hossain et al. attempted to identify factors affecting and assess the level of motivation of employees working at KFC UK ltd [3]. CK Ndirangu investigated the factors affecting employee motivation in the fast-food sector [4]. His study specifically aimed to assess the extent to which non-monetary rewards influence employee motivation, to determine the influence of financial benefits on employee motivation, and to establish the effect of working conditions on employee motivation. SL You investigated the present status of the western fast-food eating behaviors of junior high school students, and examine the relationship among the selected students' background characteristics, their nutrition knowledge of fast-food, attitude toward fast-food consumption, self-efficacy on refusal to fast food, and fast-food eating behaviors [5]. TA Phan investigated the factors that investigate the customers' evaluation and perception about determinants influencing customer satisfaction at Vietnamese fast-food restaurants [6]. Jahan determined the factors influencing the level of fast-food consumption in the adolescent population in Oman [7]. WINGROVE et al investigated the influence of various site location and branding factors on the growth of franchised fast-food restaurant brands across the greater Gauteng region [8]. Park et

al. identified how much the image factors influence on service quality, and guests' satisfaction to fast food store, to identify how much service quality influence on guests' satisfaction [9]. AD Lassen et al. identified gender differences in fast food consumers' reasons for actual fast food meal selection and their purchase intentions [10]. Based on this background, possible opportunities toward implementing healthier and more sustainable fast-food options are discussed.

However, existing researches do not investigate zones, urban economic development, population density, and other factors that influence the distribution of the number of KFC shops. Therefore, this paper put forwards the analysis to the distribution of the number of KFC shops from urban economic development, population density, and other factors. Taking the dataset of the distribution of KFC shops in the Yangtze River delta area as an example, factors influencing the number of fast-food shops is analyzed. This zone includes 25 cities. Actually, Jiang Su, Zhe Jiang and Shanghai are the most developed and lively economies in China. And Yangtze River Delta city cluster represented by Shang Hai is one of the six largest city clusters in the world. Hence, the data of KFC data in this zone is the most representative. In 2020, the GDP of this zone was more than 20 trillion yuan, consisting of about 20% of the GDP of the Chinese mainland. In this zone, there were 1993 KFC shops in 2019, which was the largest market of KFC in China. Figure 1 shows the distribution of KFC shop numbers in each city in 2019.

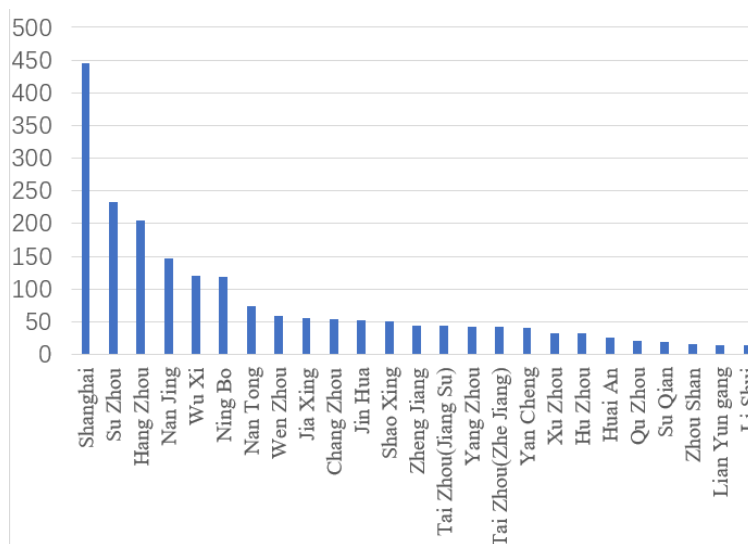


Figure 1. Number of KFC shops in each city.

Specifically, we have done the following works in this paper: Firstly, we analyzed the connection between the number of KFC shops and urban economic development, population density, and other influence factors. Secondly, the PCA technology was applied to do the principal component analysis for the influence factors. Thirdly, typical features of this zone were analyzed.

Through the analysis, the city level can be directly be seen as the major influence factor. But apart from it, by PCA, GDP, population with the unit of million, the output value of the second industry are the three key factors of the number of KFC shops in one city. In addition, the sinking market strategy of KFC shops can better suit the development and market-style of this zone.

2. Analysis

2.1 The connection between the number of KFC shops and city classes

2.1.1 Classifications of cities in Yangtze River Delta Area

According to the population size and economic scale of these cities, they are divided into 5 types.

First-tier cities include Shanghai. Shanghai is the largest metropolitans in this zone, even in China. In addition, it is the economic center of this zone. Therefore, it has the most gigantic market and massive consumer groups.

New first-tier cities include Nan Jing, Hang Zhou, Su Zhou. These cities are regional economic centers. They also have an outstanding industry clustering effect and can attract a certain number of consumers.

Second-tier cities include Ning Bo, Wu Xi, Nan Tong, Wen Zhou, Jin Hua, Chang Zhou, Jia Xing, Xu Zhou, Tai Zhou (Zhe Jiang), Shao Xing, Yang Zhou. Compared with first-tier cities and new first-tier cities, their market capacities are relatively small, but they still have excellent market potential and edges in some particular aspects.

Third-tier cities and fourth-tier cities include Yan Cheng, Zheng Jiang, Tai Zhou (Jiang Su), Huai An, Lian Yun Gang, Zhou Shan, Li Shui, Su Qian, Hu Zhou, Qu Zhou. Although the two types of cities are less complete than first-tier cities, new first-tier cities and second-tier cities in market volume, the slow-paced lifestyles.

2.1.2 Brief Analysis of the connection between cities

From Figure 1, we can see that there is an obvious gap between the first-tier city and the new first-tier city. Among new first-tier cities, Su Zhou contains the largest number of KFC shops, but that of Shanghai is nearly twice of it. In terms of new first-tier cities, there is nearly no difference between Su Zhou and Hang Zhou, but the number of KFC shops in Nan Jing is 75% of them. To explain this difference, GDP and population are the main factors.

In 2019, the GDP of Nan Jing was yuan, while that of Su Zhou and Hang Zhou were yuan and yuan respectively. In addition, in 2019, the population of Su Zhou was and that of Hang Zhou was, while that of Nan Jing was. The market volume of Nan Jing was less than that of the other two cities.

As for second-tier cities, the number of KFC shops in Wu Xi and Ning Bo was extremely high due to GDP. In 2019, the GDP of Wu Xi and Ning Bo were yuan and, much more than the following city Nan Tong, with the GDP of yuan. Except for Ning Bo and Wu Xi, there was almost no difference in other second-tier cities.

Obviously, there was no apparent difference between third-tier cities and fourth-tier cities. Overall, apart from some abnormal values, the number of KFC shops followed the distribution formula below: First-tier city > new first-tier city > second-tier city > third and fourth-tier city.

2.2 Other influence factors

Frankly speaking, it is to find the distribution formula only according to the official criteria of the city levels. From the research, it can be seen that there are also differences in cities in the same class, in terms of the economic and social parameters, such as GDP, population, population density, and urbanization rate.

For example, while Ning Bo and Yang Zhou are both second-tier cities, there are tremendous differences between these two cities, the differences are shown in Table 1.

Table 1. Special examples.

Record	City	Ning Bo	Yang Zhou
Area(km ²)		9816	6591.21
The natural growth rates of the population		2.14‰	0.60‰
Household registration population(million)		6.085	4.5714
urbanization rate		73.6%	68.20%
GDP (trillion yuan)		1.1985	0.585
GDP per capita (thousand yuan)		140	129
Per capita disposable income(yuan)		56982	45550
Primary industry (billion yuan)		32.23	29.2
Secondary industry (billion yuan)		578.29	277.821
Tertiary industry (billion yuan)		587.99	277.907

To solve this imbalance, urbanization rate and population density will be taken into consideration in the following part.

2.3 Population density

To better analyze this influence factor, we choose Huang Pu district, the densest and crowded district in Shang Hai as an example, shown in Figure 2.

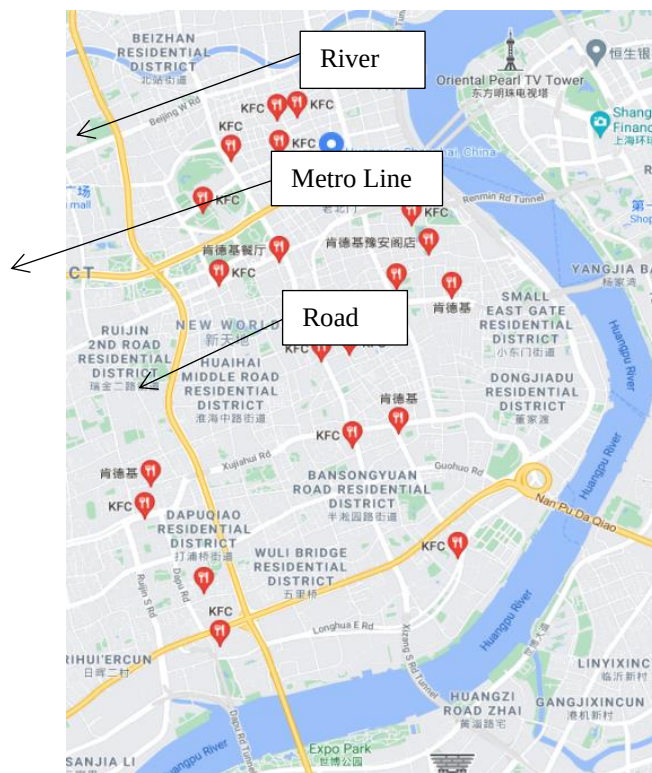


Figure 2. KFC shop numbers in Huangpu district.

From Figure. 2, except the population density, underground system, and other factors also influence the distribution of KFC shops. In Huang Pu district, population density functions mainly on the layout of KFC shops, especially in the commercial centers that can attract a dramatic number of visitors. In

addition, although metro lines also make some differences to the layout of KFC shops, they do not have such the effect of the industry clustering like the commercial center.

To reduce the effect of other influence factors as minor as possible, PCA is applied.

3. PCA

3.1 Data standardization

To better figure out the influencing factors that affect the total number of KFC shops in one particular city, principal component analysis is applied.

To straightly describe the city level, numbers are used. For example, 2 is used to represent third-tier cities and fourth-tier cities. 3 is used to represent second-tier cities. 4 is used to represent new first-tier cities and 5 is used to represent first-tier cities. X1 is city level; X2 is GDP with the unit of billion yuan; X3 is Area with the unit of square kilometers; X4 is the population with the unit of million; X5 is population natural growth rate; X6 is urbanization rate; X7 is GDP per capita with the unit of thousand yuan; X8 is per capita disposable income with the unit of yuan; X9 is the output value of the primary industry with the unit of billion yuan; X10 is the output of the second industry unit of billion yuan; X11 is the output of the third industry with the unit of billion yuan; X12 is the number of KFC shops. In addition, there are 25 evaluation objects. The i-th evaluation object and its j-th index is denoted by x_{ij} . In the first step, data standardization is applied to transform all indicator value x_{ij} into standardized indexes $\bar{x}_{ij}$, the calculation process is shown as (1)~(3).

$$\bar{x}_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}, (i=1, 2, \dots, 25, j=1, 2, \dots, 12) \quad (1)$$

$$\bar{x}_j = \frac{1}{n} \sum_{i=1}^n x_{ij} \quad (2)$$

$$s_j = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_{ij} - \bar{x}_j)^2} \quad (3)$$

$\bar{x}_j$ is the sample mean of the j-th index while s_j is the standard deviation of the j-th index. Similarly, $\bar{x}_i = \frac{x_i - \bar{x}_i}{s_i}$ are called standardized index variables.

3.2 Compute the related coefficient matrix

Related coefficient matrix $R = (r_{ij})_{m \times m}$

$$r_{ij} = \frac{\sum_{k=1}^n \bar{x}_{ki} \times \bar{x}_{kj}}{n-1} \quad (i, j=1, 2, 3, \dots, 12) \quad (4)$$

$r_{ii} = 1$, $r_{ij} = r_{ji}$, r_{ij} is the related coefficient of the i-th index and j-th index.

3.3 Select Principal components

Calculate the information contribution rate and the accumulative contribution rate of the characteristic value σ_j ($j=1, 2, 3, \dots, 12$).

We call it $b_j = \frac{\sigma_j}{\sum_{k=1}^m \sigma_k}$, the information contribution rate of $y_j \cdot \rho_p = \frac{\sum_{k=1}^p \sigma_k}{\sum_{k=1}^m \sigma_k}$ is the accumulative contribution rate of pivotal components $y_1, y_2, y_3, \dots, y_{12}$. When ρ_p approaches 1, p index variables y_1, y_2, y_p are selected as p pivotal components to replace m index variables, so complex analysis can be made. Then calculate complicated scores by formula (5).

$$Z = \sum_{j=1}^p b_j y_j \quad (5)$$

b_j is the information contribution rate of the j -th pivotal component. Results show that that GDP, population with the unit of million, the output value of the second industry are the three key factors of the number of KFC shops in one city.

4. Typical features of yangtze river delta area

4.1 Background

In China, Jiang Su, Zhe Jiang, and Shanghai have developed their development style, i. e. rural enterprises. Therefore, there are just minor differences between urban areas and rural areas in terms of the economic aspects. This development style is called the Southern Jiangsu model. Hence, in this zone, apart from highly developed metropolitans, there are also competitive small and medium-sized cities that also have relatively big market potentials. Even in some towns and countrysides also have stable client resources. Recently, KFC puts forward a new marketing strategy, the sinking market to occupy more and more market shares. In my opinion, this market strategy can better suit this zone.

4.2 Case study

To test the feasibility of this strategy, in this case study, a comparison will be made between Su Zhou and Nan Tong because they had similar development features of rural enterprises. In 2019, the urbanization rate of Su Zhou was 77% while that of Nan Tong was 68.1%. Su Zhou governed 4 counties and Nan Tong had 4 counties.

Compared with Su Zhou, the distance between counties in Nan Tong is more than that of Su Zhou. In addition, the density of transition lines in Su Zhou is larger than that in Nan Tong. Consequently, there are more market blanks in Nan Tong.

5. Conclusion

In this paper, we use the dataset of KFC shops in the Yangtze River delta area and analyze the connection between the number of KFC shops and urban economic development, population density, and other influence factors. PCA technology was applied to do the principal component analysis for the influence factors. Typical features of this zone were analysed. It turns out that the city level can be directly be seen as the major influence factor. But apart from it, by PCA, GDP, population with the unit of million, the output value of the second industry are the three key factors of the number of KFC shops in one city. In addition, the sinking market strategy of KFC shops can better suit the development and market-style of this zone. In the future, the clustering method will be applied to analyze the distribution of KFC shops in cities and the countryside. What's more, machine learning and deep learning technology can be applied for further study. In addition, data from fast food shops of other brands will be collected to generalize the method and model created in this paper. In this zone, the location of KFC shops is closely connected with the population density and transportation line. However, KFC's market strategy should also feature in the sinking market to form a predominant market edge by attracting potential clients in the suburban area.

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