

The Influential Factors on Fast-food Restaurant: Analyzing from the Perspective of Big Data

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Abstract. In recent years, with the development of big data, precision marketing has helped companies improve customer loyalty and increase revenue through the analysis of consumer behavior and preferences. The main purpose of this research is to find the main effectiveness factors on customer groups--college students of fast service restaurants in the United States and offer recommendations based on the analysis for how the business should proceed with its marketing efforts. This paper further develops the Logit model by adding variable data of different dimensions to the model. Grabbed high-frequency words and equation modelling were performed using R studio and linear regression. Findings revealed that college students are the largest proportion of consumers in the quick service restaurants paper investigated. It helps avoid the extensive meaningless promotion of quick service restaurants which gives the restaurants clear direction of strategy improvement.

Keywords: Big Data; Fast-food Restaurant; customer groups.

1. Introduction

In recent years, the fast-food industry has developed rapidly and there are exciting and interesting trends that will expand in 2021. The market size of the quick service restaurant industry in the United States was forecast to reach 281.68 billion U.S. dollars in 2021. Fast service restaurant is sometimes referred to as limited-service restaurants (LSRs), but more commonly known as fast food restaurants. The revenue of the fast-food restaurant industry in the United States reached over 200 billion U.S. dollars in 2020 [1]. The paper found that from 2020 to 2021 the total assets of the fast-food industry increased by nearly 40 billion dollars. Therefore, the huge potential of the quick service industry cannot be ignored and it was one of the leaders of American catering industry. With the improvement of living standard and average salary, customers pursue higher quality of food, better dining environment and quality service experience even in convenience based quick service restaurants. More efficient and technical mode of operation is gradually emerging. Fast service restaurants start to provide self-ordering, customers can use their smart phones to order food. Smart appliances and artificial intelligence generally appear in the restaurant. Potential value-added services of quick casual restaurants include Wi-Fi, air condition, 24-hour operation and lots of individual seats. Therefore, fast service restaurant not only keeps its traditional convenience but also adds many new advantages to attract young people.

Furthermore, to the best of our knowledge, in tips understanding of the customer loyalty model and its relationship between the customer, restaurants can come out with the most efficient service strategy. And the reason to promote customer loyalty is because those customers can help grow restaurants business faster and restaurants could use this data to better fit customer's needs. Younger adults have a high consumption of fast food. Individuals aged 19 to 20 years consumed fewer calories from home and more calories from fast-foods as compared to adolescents 12 to 18 years of age [2]. Adults between 20 to 29 years of age had significantly greater consumption of fast food, approximately four times greater, as compared to those aged 55 years and older [3]. College students aged 19 to 25 years have reported that the top reasons reported for fast food consumption were convenience and cost (convenience being the top reason) [4]. Thus, based on this information, this research object is college students.

This study contributes to what's the factors that affect customer loyalty of college students in the fast service restaurants. The precise data of this paper collected from a local American fast service restaurant and fifty consumers' records of consumption in the restaurant. The paper uses the customer loyalty program to calculate the specific number of loyalties of each customer. In the third section the paper continues to talk about how to analyze this information and how it relates to the relationship between college students and America's quick service restaurants.

2. Literature Review

This paper aims to achieve the purpose of precision marketing based on the social media of customers and the location interest in the context of big data. By reviewing the impact of customer loyalty, data of social media and location interest to explore how this factors to affect the company's revenue and to determine company's customer groups.

2.1 Customer Loyalty

Over the past decade, most of the research pays particular attention to the concept of customers loyalty is a more important determinant of profit than market share, Reichheld and Sasser (1990) have been able to show that a 5% increase in customer retention rate can increase corporate profits by 25%-85% [5]. James Vander Putten, further proved that the ratio of the best customers in the restaurant industry is, loyal customers to other customers, is about 13:1 which demonstrated that catering companies have a stable customer base is very important to the development of the company. Researchers agree that firms reduce marketing costs and increase profits by enhancing customer loyalty [6]. Loyal customers are more likely than non-loyal customers to engage in positive word-of-mouth (WOM) behaviours and spend extra money in a specific service operation [7]. In addition, loyal customers are less costly to serve because they know the product/service well and require less information [8].

2.2 Social Media & Location Interest

Besides, Idemudia & Jones demonstrated that precision marketing has been recognized as a key means of generating profit for enterprises because it delivers more accurate product information to customers based on the understanding of customers' consumption behaviours and preferences, which can improve the purchase intention of consumers [9]. Location-based mobile marketing recommendation as one of the hot spots in precision marketing. Chunyong Yin, Shilei Ding & Jin Wang focuses on location feedback data of user and proposes a location-based mobile marketing recommendation model by convolutional neural network (LBCNN) shows that the model is better than the traditional recommendation models in the terms of accuracy rate and recall rate, both of which increase nearly 10% [10]. Y. L. Allan & Brimicombe have suggested to create a space time envelop to limit the area of relevance for the user using current position, direction of travel and some parameters defined by the user. The amount and type of location related data that the users receive are influenced by the shape of the space time envelope [11]. Bendle & Wang investigated that it is with no surprise that Marketing has become from the start a field for experiments with Big Data approaches. Recent sources of loads of data include social media and mobile applications: both have proven to have a huge impact on customers' decisions, directly affecting brand building [12]. According to Sachoff, the main advantage of having a social network presence is "the amount of information an organization can gain about its customer base." He continues, saying that information can be mined regarding all sorts of trends, including product development, customer feedback, loyalty management, and customer segmentation, among others. As technology rapidly increases and the information age expands, it is necessary think about how these social networks such as Facebook and Twitter are having a huge impact on influencing customers' decisions, leading organizations and brands to incorporate information originated in such platforms in their Marketing solutions [13].

In view of all that has been mentioned so far, customer loyalty, social media information and location network can play an important role in marketing guidance in restaurant and other service industries. All mentioned reviews serve as the theoretical support for this paper and is used in the verification process.

3. Methodology

3.1 Research Design

The main purpose of the research is to find the main customer groups of fast service restaurants in the United States and offer recommendations based on the analysis for how the business should proceed with its marketing efforts. This paper further develops the Logit model by adding variable data of different dimensions to the model. Grabbed high-frequency words and equation modelling were performed using R studio and linear regression.

3.2 Data Sources

Data in this study comes from a database of a university. This paper has screened a large amount of data and obtained relevant data from a local chain restaurant in the United States. The chain has four locations in the metro Atlanta area. It is a fast-casual business which primarily has burgers on its menu and alcoholic beverages served at its locations. Like many restaurants, it was adversely affected by the COVID-19 pandemic.

The specific data includes three parts.

Part 1: The amount spent in the restaurant by 48 customers who spent in the restaurant in the past 15 months.

Part 2: The data was divided into 10 groups; each group consists of 5697 related the composition of social topics. Customer scores each group of topics according to their degree of interest. The total score of each customer is the same. This study calculates the data according to the Weight coefficient.

Part 3: This part is similar to the second part which consisting of 10 groups, each group is composed of 1301 related locations. Each customer will score each group of locations according to their degree of interest. The related data process is the same as the second part.

3.3 Data analysis

3.3.1 Loyalty.

Step 1: Data compilation, converting all customers' consumption in the restaurant to a 0-1 model, that is, the increase in consumption compared with the previous month is recorded as 1, and the rest is recorded as 0.

Step 2: Regression Refresher

$$\mu_i = \alpha + (\beta_1 \cdot X_{1i} + (\beta_2 \cdot X_{2i}) + \dots + (\beta_k \cdot X_{ki}) \quad (1)$$

$$Y_i \sim N(\mu, \sigma^2) \quad (2)$$

The mathematical expression for $f(\cdot)$ reflects how likely the value Y is to be observed under parameters θ . Start by observing a sample $y_1, y_2, \dots, y_n \sim f(Y|\theta)$.

Step 3: Logit model

$$\text{logit}(p_i) = \log\left(\frac{p_i}{1-p_i}\right) = X_i^t \beta \quad (3)$$

$$p_i = \frac{\exp(X_i^t \beta)}{1 + \exp(X_i^t \beta)} \quad (4)$$

When outcome variable is binary, i.e., a yes or no choice → Bernoulli distribution.

When substitute actual data into the model, the paper includes inertia and loyalty effects. When $y=1$ is not true in the previous period, there will be no inertia, and the impact of loyalty is not present because $y=0$ in the previous period.

Step 4: Likelihood function

$$y_i \sim \text{Bernoulli}(p_i) \Leftrightarrow y_i = \begin{cases} 1, & p_i \\ 0, & 1 - p_i \end{cases} \quad (5)$$

$$f(y_1, \dots, y_n | p_i) = \prod_{i=1}^n (p_i^{y_i} (1 - p_i)^{1-y_i}) \quad (6)$$

$$\frac{d}{dp_i} LL(y_1, \dots, y_n) = \frac{\sum_i y_i}{p_i} - \frac{\sum_i (1-y_i)}{1-p_i} = 0 \quad (7)$$

If $y=1$, the corresponding observed likelihood is given by the values in columns L-V. If $y=0$, the likelihood of the observed data is given by $1-\text{Pr}(y=1)$. The natural logarithm (ln) is used to rescale the probabilities. In order to maximize this function in the models → maximum likelihood.

3.3.2 Social Topic & Location Topic.

Instead of considering only loyalty factors, social topic and location topic are also analyzed as factors affecting restaurant revenue growth. The methods are shown below

Step 1: The analyzation is applied on the same restaurant as the loyalty part shown before, therefore, the same 0-1 model is utilized regarding the consumption growth.

Step 2: The Regression Refresher is converted into the linear equation shown below by adding social topic as the variable X_{2i} , where β_2 is the coefficient of social topic which equals to the scores of social topics for different customers.

Step 3: Logit and Likelihood function: Since the same 0-1 model is applied in this part, the logit function as well as likelihood function are also unchanged as introduced in Loyalty part, instead of new μ_i being used. Simple LL calculated by the sum of likelihood is maximized by Non-linear GRG Solver.

Step 4: Repeating Step 1 to 3 with 10 for 10 social topics gives the 10 maximum Simple LL. By selecting the largest value among the results of 10 results, the social topic that refers to customers who most likely to increased consumption in this restaurant is illustrated.

Step 5: Now, one more variable, the location topic, is introduced into the step 2, where the X_{3i} refers to the variable of location topic, β_3 is considered as the score for each location topic, and β_2 is given by the score of social topics derived from the one with maximum Simple LL shown in step 4.

Step 6: By repeating Step 1 to 3, 10 results of maximum Simple LL can be calculated with scores of 10 groups of location topic. Therefore, the largest value calculated is regarded as the most interested location topic that customer who tend to increase consumption in this restaurant.

Although the rough profile, including the social and location interest, of target customers is conducted from steps before, the amount of information still tremendous to implement a precious marketing strategy. To further narrow down the scope of customer profile, High-frequency word analysis method are utilized for the specific topics given in Step 6. There are varying tools can be chosen for High-frequency word analysis, such as R-studio, Word-cloud and Excel. Here the Excel approaches is selected.

Step 7: The phrase is split into individual words by “Text Columns” function in Excel, and then all words are put into one column to create a “Pivot Table”, in which the frequency of each word can be counted. Top 5 words with highest frequency illustrate the social image of target customer. Remembering, the words of Article and Conjunction like “a”, “the”, “of”, and so on should be eliminated from the results. Simply, the additional 5 words can be given from the location topic. From

these words, one more precise icon of target customer is shown, and can be discussed for the further business suggestions.

4. Result

4.1 loyalty

Based on the customer loyalty data, this study noticed that if the customer visit to the restaurant previously, there is a 40 % of change for them visit next time, but if the customer did not visit the restaurant previously, there's only 14% of change for them to go there. Customer loyalty is a very effective way, enterprises can be used to evaluate customers, in order to make corresponding countermeasures.

4.2 Social Topic & Location Topic

When added the social media data to the customer loyalty program, this study got a brand-new possibility of customer consumption growth. In all the data of social media, it included all the small points in a big topic. The paper found that customers who are interested in the fourth topic, with higher month to month expenditure data, have higher possibility to increase consumption in the restaurants. Topic four, the fourth column, contains a large number of Characteristics, there may be no connection between these characteristics, but the customers who have these characteristics at the same time have an important connection with the restaurant operation. These customers are most likely to increase their monthly consumption, so they are the most valuable and potential customers for the restaurant.

This study transferred the Topic four as a specific factor with loyalty effect together. Then added 10 different location interest one by one in the model to calculate the maximum of sample likelihood. The result is that the location topic 6 has the most contribution to the customer increased, shown in Table 1 and Table 2.

Table 1. The maximum Simple LL results for 10 different Social topics

Number of Social topics	Intercept α	Coefficient of Loyalty Effect β_1	Coefficient of Social topic β_2	Sample LL
1	-1.79	-0.79	1.02	-280.52
2	-1.52	-0.78	-0.77	-281.04
3	-1.72	-0.78	0.92	-280.83
4	-1.85	-0.81	2.92	-278.87
5	-1.81	-0.81	1.39	-279.34
6	-1.65	-0.77	0.65	-281.38
7	-1.54	-0.78	-0.90	-280.81
8	-1.61	-0.77	-0.01	-281.48
9	-1.56	-0.77	-0.91	-281.27
10	-1.66	-0.80	0.88	-280.18

Table 2. The maximum Simple LL results for 10 different location topics

Number of Location topics	Intercept α	Coefficient of Loyalty Effect β_1	Coefficient of Social topic β_2	Coefficient of Location topic β_3	Sample LL
1	-1.96	-0.82	2.88	0.70	-278.57
2	-1.90	-0.82	2.95	0.33	-278.80

3	-2.01	-0.83	3.00	1.37	-277.96
4	-1.95	-0.82	3.09	0.65	-278.61
5	-1.94	-0.83	2.90	1.04	-278.48
6	-2.04	-0.90	3.09	2.42	-275.36
7	-1.98	-0.84	2.46	2.51	-277.74
8	-1.90	-0.82	2.95	0.48	-278.57
9	-1.83	-0.81	2.89	-0.47	-278.86
10	-1.92	-0.89	5.20	-2.62	-275.84

4.3 High Frequency Word Analyze

The result that R-studio and Excel has produce as Table 3 and Table 4. For social media part, the paper can find that university, magazine, music, sports have high frequency to show up. For the location interest data, restaurant, shopping, bars, fashion has always been appeared. So as all these key words got it could have an image of the most valuable potential customer. Maybe college student who like magazine, sport and who like go shopping, restaurant, or bars. Then focus on that kind of person may adjust in marketing strategies to meet their interest.

Table 3. High-frequency word analysis results of Social Topic 4. (Top 5 words are highlight and the word frequency less than 60 times is hidden)

Word	Count: Social Topic4
the	344
university	212
of	180
magazine	158
and	139
&	87
college	65
new	62
state	59
music	47
sports	34
york	33
news	31
american	31
...	...

Table 4. High-frequency word analysis results of Social Topic 4 (, where the top 5 words are highlight and the word frequency less than 30 times is hidden)

Word	Count: Location Topic 6
restaurants	624
shopping	367
food	242
nightlife	190
bars	165
fashion	120

active	111
tradamerican	96
sandwiches	83
homeandgarden	82
arts	68
newamerican	65
breakfastbrunch	65
...	...

5. Discussion

This study makes important contributions toward understanding the formation of customer loyalty and customer groups of college students in quick service restaurants. Customer loyalty data is a significant predictor of customer to do next purchase, the study can charge the customer loyalty by the number of times and time period of consumption in the restaurant in the past 15 months. In addition, ten groups of customer social media information and location data are the key factors that this paper used to analyse. Findings revealed that College students are the largest proportion of consumers in the quick service restaurants paper investigated. It helps avoid the extensive meaningless promotion of quick service restaurants which gives the restaurants clear direction of strategy improvement. In another way, knowledge of the impact of customer loyalty and degree of interest from each customer can help restaurants find the best way of advertising their products, improve their service quality targeted and maximize their profits. The convenient consumption mode and low price attracts college students to purchase in the quick service restaurants. For instance, restaurants could change their outlook in a more personalized and fashion style, and additional sense of art will also help attract college students. Based on the collected data, quick service restaurants can change their original form and create an active atmosphere and fascinating decorations to attract more potential customers.

In recent research, people talked about the effect of perceived service quality dimensions on customer satisfaction, trust and loyalty. And they noticed that loyal customers are indeed crucial to business survival. A research paper in 2017 that talked about understanding customer satisfaction in the UK quick service restaurant industry, and the influence of the tangible attributes of perceived service quality. Responsiveness and assurance are two fundamental factors which significantly impact customer satisfaction in the UK fast food market [4]. Peoples survey of market and customers generally focus on customer satisfaction and customer behaviour, but not specific to a certain type of customer. Customer loyalty is mentioned separately without enough details. Currently, there is a lack of investigation and study on Customer loyalty and college students' consumers in American quick service restaurant industry. Therefore, the results of this discussion examined the significance of improving customer loyalty and found out the most critical way to attract college students as customers in the US market. Knowing the great potential of US fast food markets development in the future, and makes up for the vacancy of current market research in this aspect.

As in any study, there are some limitations of the research that should be understood when interpreting the results. First, social media data and location data were collected only from 48 sample customers. Which cannot deny that the results may have certain contingency. Besides, there is no way to make sure that samples were randomly chosen or not. And it is too difficult to obtain customers' detailed personal information, which is an invasion of privacy. This study believed that if it can get some sort of information resources such as app usage records, searching records, and College student survey expenses records, it might lead to better and accurate results. Finally, excluded small-scale contingency, the results have established reference value after the accurate calculation.

6. Conclusion

The investigation and study of a local chain quick service restaurant in the United States proves that customer loyalty plays an important role in the consumption and uses the customer loyalty model to find out the most valuable customer groups based on the social media information and location data. The study collected data from 48 customers who spent in the restaurant in the past 15 months. The paper found out the percentage of a previous visit customer to do next purchase is much higher than the customer who did not visit previously. The paper also found that customers who are interested in the fourth social topic with higher month to month expenditure data have higher possibility to increase consumption in the restaurant. In addition, the following words are the high frequency words appearing in the fourth topic, university, magazine, music and sports. And in the part of location, topic six has the most contribution to the customer. Besides, the high frequency words are restaurants, shopping, food, nightlife and bars. Both of the keywords in social and location data lead to college students, a fashion group formed with young adults. It confirms the conjecture that college students are the biggest consumer group and the most valuable potential customers of this quick service restaurant. This result also has a certain representative reference significance for all of the quick service restaurants in the United States. Quick service restaurants which have similar characteristics with these local chain restaurants might make strategy plans attract college students and improve their service in the best direction.

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