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# A Picture Can Tell a Thousand Words: Understanding Visual Digital Contents of Chinese Restaurants

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**Keywords:** Image analysis, Text mining, Deep Learning, Restaurants, Digital consumer behavior

## 1. Research Problem and Literature

In this era of Marketing 4.0, digital content seems very important in the culinary tourism. Before this era, restaurant managers used to utilise costly and time intensive survey to understand their consumers (Greenlaw and Brown-Welty, 2009). Specifically, Restaurant's consumers are posting regarding their experience in the restaurant through different digital contents (Moe, Netzer, and Schweidel, 2017). Previous research has investigated different types of digital contents such as product reviews (Gensler, Völckner, Egger, Fischbach, and Schoder, 2015; Moon and Kamakura, 2017; Tirunillai and Tellis, 2012, 2014), consumer messages posted in online forums (Netzer, Feldman, Goldenberg, and Fresko, 2012), social tags (Nam, Joshi, and Kannan, 2017; Nam and Kannan, 2014), social connections (Culotta and Cutler, 2016), and tweets (Liu, Burns, and Hou, 2017). However, there have been very little research done to investigate the visual digital content such as images or photos posted online. This research fills this gap by implementing image clustering to find out types of contents related to restaurants posted over the online. Visual elements attract the user's attention because they are processed faster and easier than text (Powell *et al.*, 2015). A visual image can also amplify the response of users to textual messages (Geise and Baden, 2015), which can lead to involvement through likes, comments and sharing with others. This visual information can then be used to increase the efficiency of targeted advertising, and to support value and advertising co-creation (Koivisto and Mattila, 2018).

With the advancement of the computer vision field, the researcher can collect and assess visual data (Mulfari, Celesti, Fazio, Villari, and Puliafito, 2016). Deep learning, specifically convolutional neural networks, can now recognize objects (Ma *et al.*, 2018). Therefore, deep learning approaches can be used to classify images based on similarities between images. This research assesses the types of contents posted by consumers and managers of restaurants regarding restaurant experience.

## 2. Methodology and Analysis

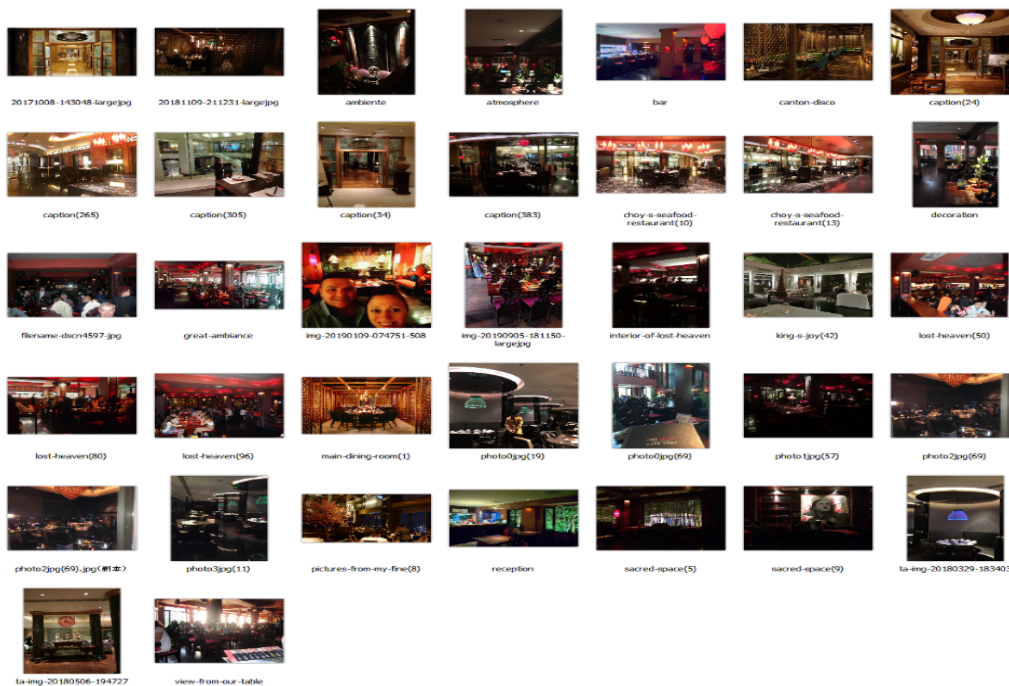
### 2.1 Image collection and clustering

First, we collected 4000 photos of several Chinese restaurants from Trip Advisor website. In this paper used for analysis Inception V3 for image recognition and it is Google's deep neural

network which trained on the ImageNet data set (e.g., Krizhevsky, Sutskever, and Hinton, 2012). This procedure is called image embedding. Image embedding through the use of neural network produces an enhanced data table for each image based on the contents of the image. During the next step, we measured the similarities between photos by measuring the cosine distance of the corresponding vectors. In the end, the data generated from the cosine distance metric was used for hierarchical clustering. We can find similar types of photos and differences among the group of photos through this hierarchical clustering procedure and it helped us to identify different types of photos related to restaurants posted online. Image analysis and hierarchical clustering generated 12 clusters. These clusters provide the types of photos posted online both by managers and consumers of restaurants:

1. Atmospheric: Related to the air or kind of atmosphere, always consisting of lighting and music. It often creates a distinctive mood, especially romantic or nostalgic.

Figure 1. Images of Atmospheric in restaurants (Source: Images cluster generated through the help of deep learning)



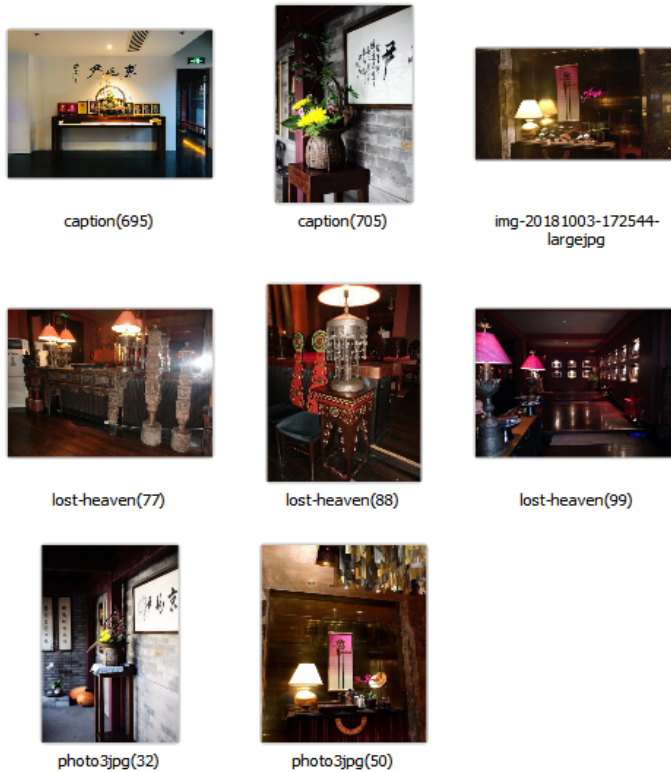
2. Table Decorations: The design of components on the table which includes plates, chopsticks, spoons, forks, cups, etc. They use customized patterns or different colors to match the tone of the restaurant or the connotation of the dishes.

Figure 2. Images of Table Decorations (Source: Images cluster generated through the help of deep learning)



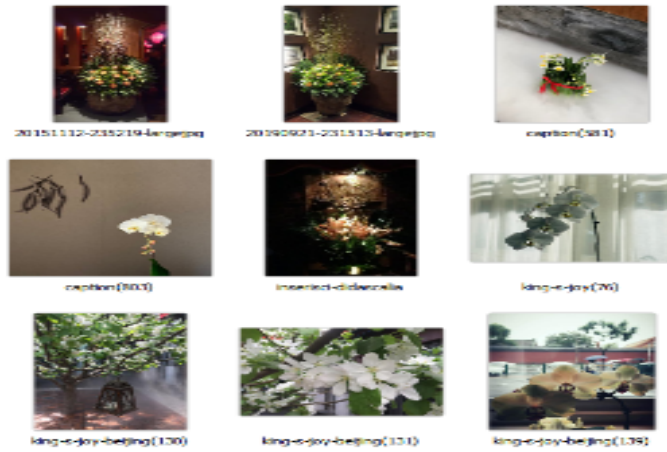
3. Decorations using lamps in Restaurants: Different brightness, different colors, different appearances, sizes, and placement methods will create different dining environments.

Figure 3. Images of Lamps in Restaurants (Source: Images cluster generated through the help of deep learning)



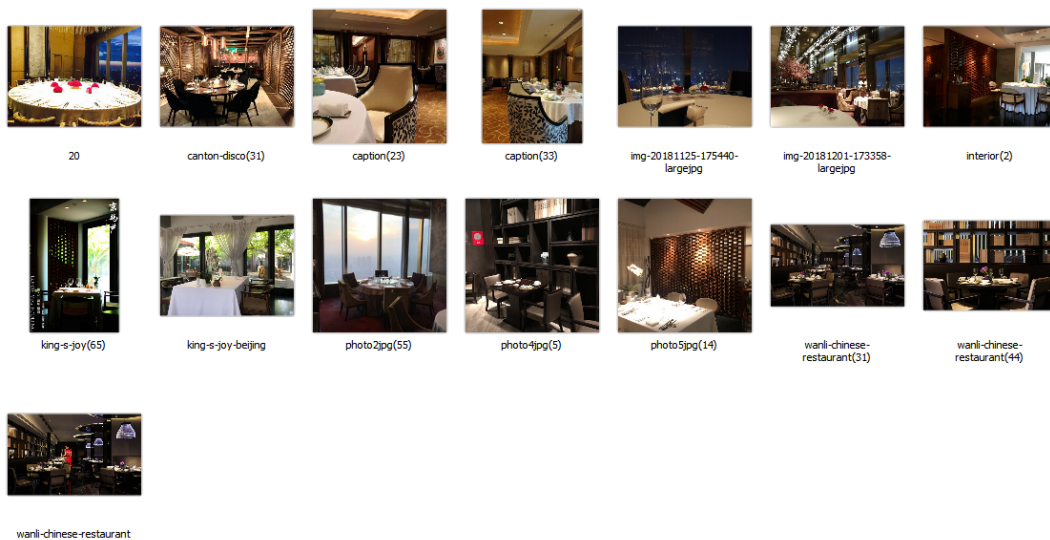
4. Decorations using plants in Restaurants: Chinese people believe in feng shui, so the placement of indoor plants is usually very particular.

Figure 4. Images of Plants in Restaurants (Source: Images cluster generated through the help of deep learning)



5. Pictures of Interior Design in Restaurants: Round table or a square table, what material furniture to use, the main color of the dining area, the number of tables and chairs in a certain space, and the placement of different furniture in the private room can be seen in the restaurant's careful thinking.

Figure 5. Images of Interior Design in Restaurants (Source: Images cluster generated through the help of deep learning)





6. Award Picture of Restaurants: The certificate of merit is a reflection of the restaurant's capabilities and specifications, and is used to reflect the restaurant's professionalism, popularity, and compliance with hygiene standards.

Figure 6. Images of Award Picture of Restaurants (Source: Images cluster generated through the help of deep learning)



2014



2015(1)



caption(835)



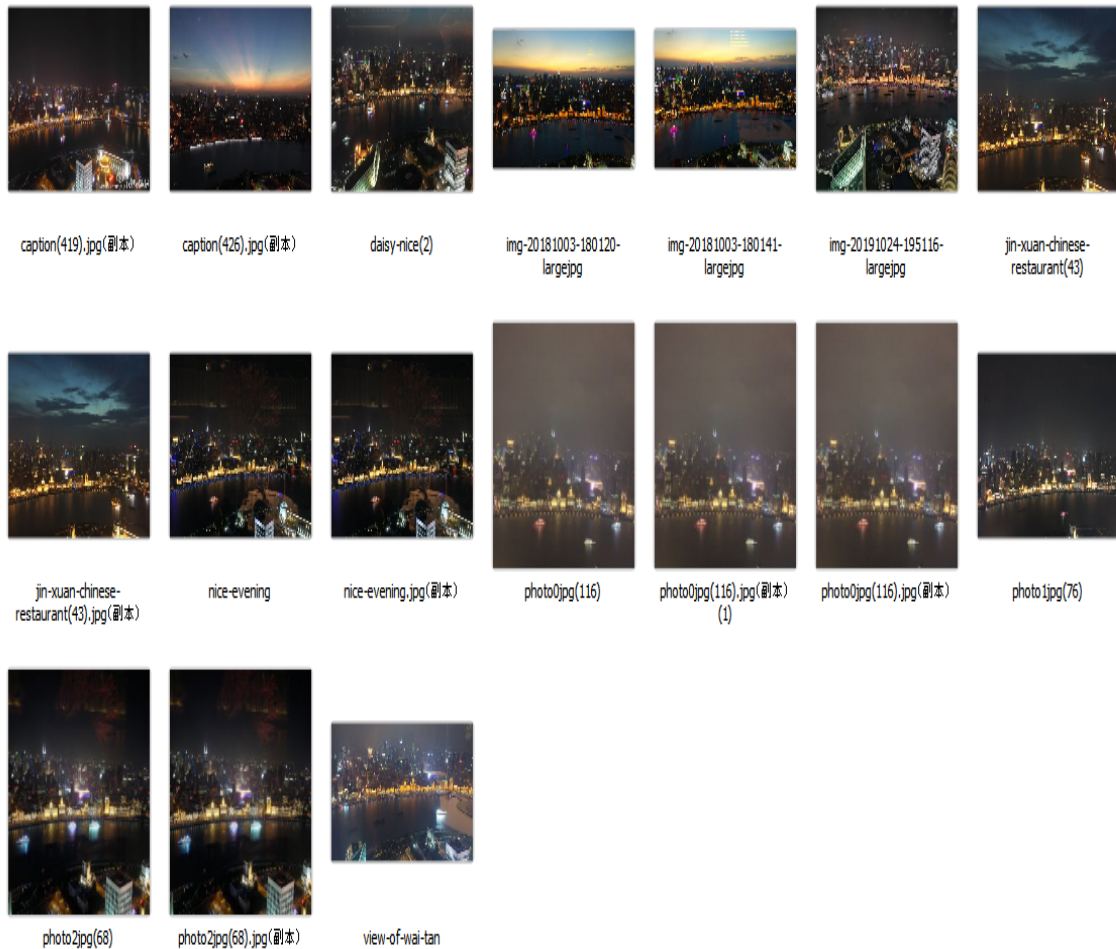
kingsjoy(34)



that-s-beijing

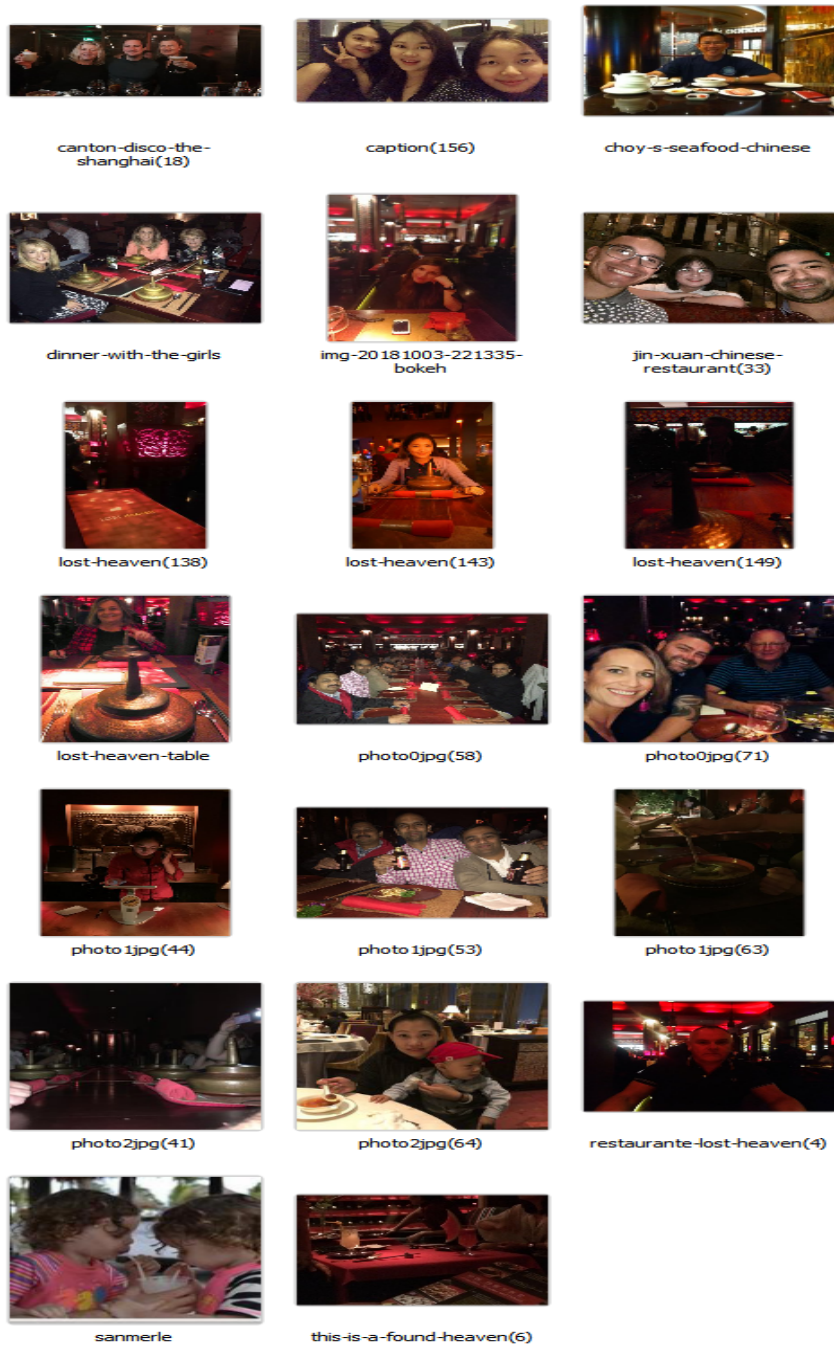
7. Views from the restaurants: Depend on the location of the restaurant, the visual experience while dining is different. Many customers patronize a restaurant for good visual enjoyment while dining. Places overlooking the city are often noticed, and good nights are lingering.

Figure 7. Images of Views from the Restaurants (Source: Images cluster generated through the help of deep learning).



8. Consumers having fun in the restaurants: When people are happy, they always think of using the camera to record the momentary beauty and use photos to convey the sense of joy. Three or five friends, family members, group photos posted online, can show the restaurant's dining service quality and dish satisfaction.

Figure 8. Images of Consumers Having Fun in the Restaurants (Source: Images cluster generated through the help of deep learning)



9. Consumers Promoting Foods: When expressing their satisfaction with the dishes and customers, the guests will ask for photos with the restaurant's signature dishes or logos. Sometimes they take the initiative and sometimes they invite them to the restaurant.

Figure 9. Images of Consumers Promoting Foods (Source: Images cluster generated through the help of deep learning)



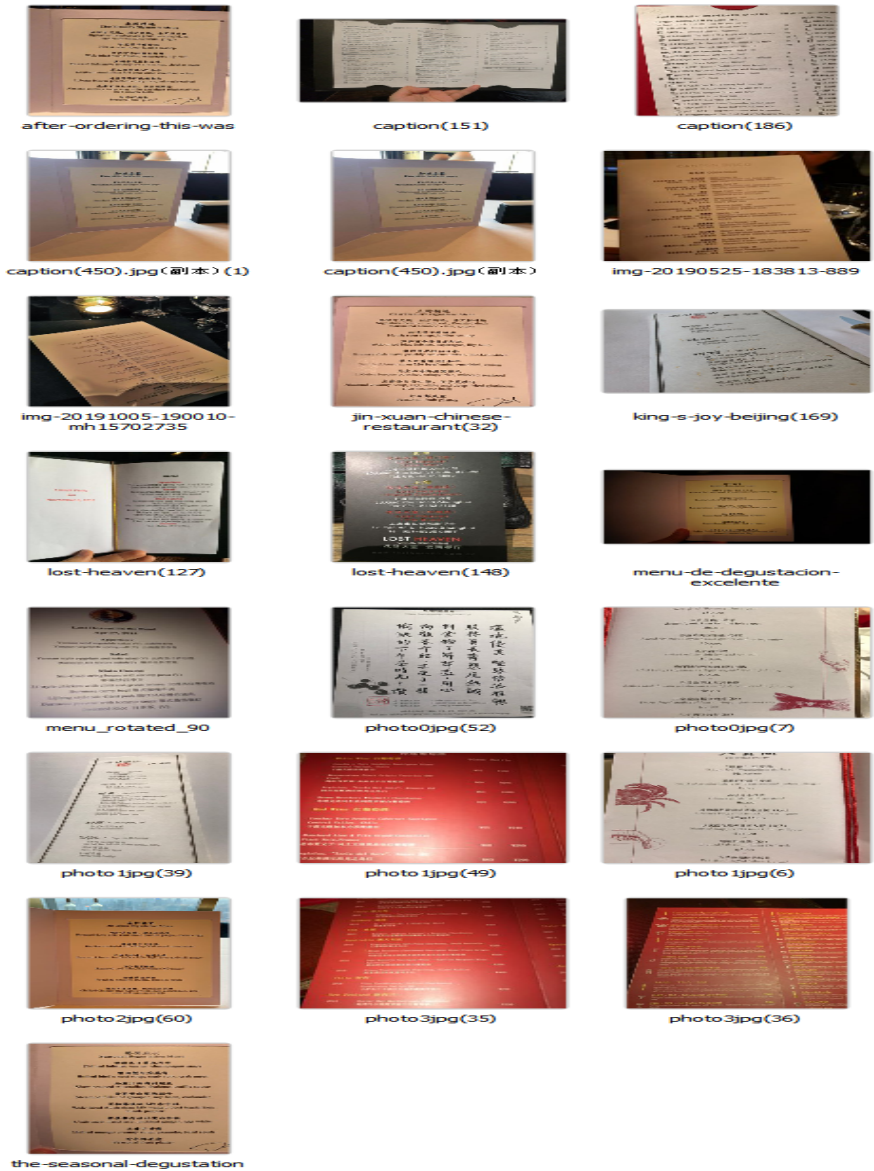
10. Consumers Testimonials: In some restaurants, there will be a space to show the customer's evaluation of the store, or a message board is hung at a certain place in the restaurant, or a photo is taken with a similar blessing, or message book is used to leave an impression. Through this form, the restaurant has established more connections and concerns with customers. These customers also endorse the restaurant, which is more convincing. This is very important for the restaurant to establish a good image in the minds of the public.

Figure 10. Images of Consumers Testimonials (Source: Images cluster generated through the help of deep learning)



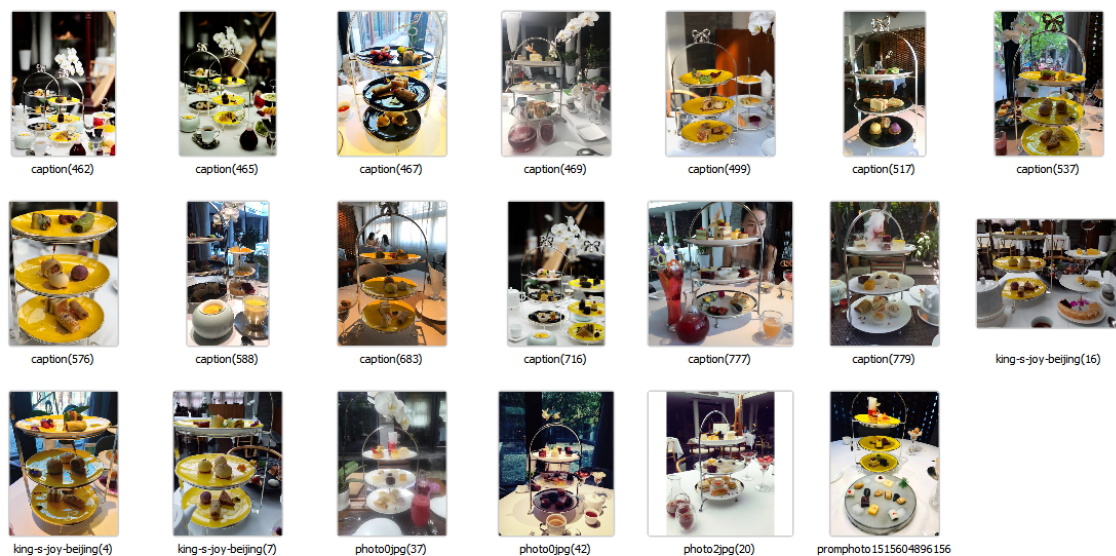
11. Pictures of Menus: The menu is mainly used to remind customers of the dining content of this restaurant. It usually highlights some special dishes to attract customers and give customers the opportunity to make their order in advance. The design of the menu is usually very particular. Its color should be consistent with the decoration color of the restaurant. It should pay attention to the classification. It recommends special dishes through special symbols.

Figure 11. Images of Menus (Source: Images cluster generated through the help of deep learning)



12. Food and Drink Presentation: Among the pictures uploaded by many customers, the photos of dishes and drinks are the most, which is enough to show that customers value this part of the content. Some well-prepared foods and drinks often arouse customers' favor. For customers, a good dish appearance can add points to the meal and increase the value of the meal. The analysis found some of the noodles installed by the steamer are mostly traditional Chinese food. For many Chinese families, this is an indispensable food for three meals a day. Some beautifully set afternoon tea dessert sets are the first choice for delicate girls. Some quilts and drinks with different decorations are printed on each other, which further enhances the customer's love. Customers are likely to be in love with this restaurant because of such a photo.

Figure 12. Images of Food and Drink Presentation (Source: Images cluster generated through the help of deep learning)



## 2.2 Extracting information from texts

In this research have been asked 125 respondents from China to complete three open-ended survey questions. A word cloud analysis was conducted using the orange program. The size of the word represents how frequently a word compare to other words appeared in the responses. It provides a visual illustration of frequently used words and other words used in open-text responses. It helped to get meaningful and informative data from short responses:

I. "What they want to know before going to a restaurant?": 1) Dishes; 2) Price; 3) Taste; 4) Environment; 5) Service.

II. "What motivates them to post reviews online?": 1) Discounts; 2) Gifts or Coupons; 3) Good Service from owner or employees; 4) Good Photos.

III. "With whom they want to share their reviews?": 1) Owners (Charming); 2) Employees; 3) Other consumers; 4) Other restaurants; 5) Everyone.

## 3. Conclusion

This empirical study has theoretical and practical implications for restaurant image and marketing management in social media. First, the study shows which specific aspects of

restaurant services, reflected in the visual content provided by users and managers of restaurants, actually led to a positive assessment of the reviews. Secondly, this paper provides a text analysis of consumer's behavior before going to a restaurant and motives to share information after purchasing. Further research should study the behavior of tourists with the addition of variables such as the publication of posts on the first visit and repeated visits to restaurants, time of visit, level of tourist satisfaction.

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