Maryam Oluwafunmilayo Ajasa,[*1] Susan W. Arendt,[1]
Jewoo Kim,[1] and Shannon Coleman[2]

[1]Iowa State University, 2302 Osborn Drive, Ames, IA 50011, USA
[2]Louisiana State University Agricultural Center, 293 Knapp Hall,
Baton Rouge, LA 70803, USA
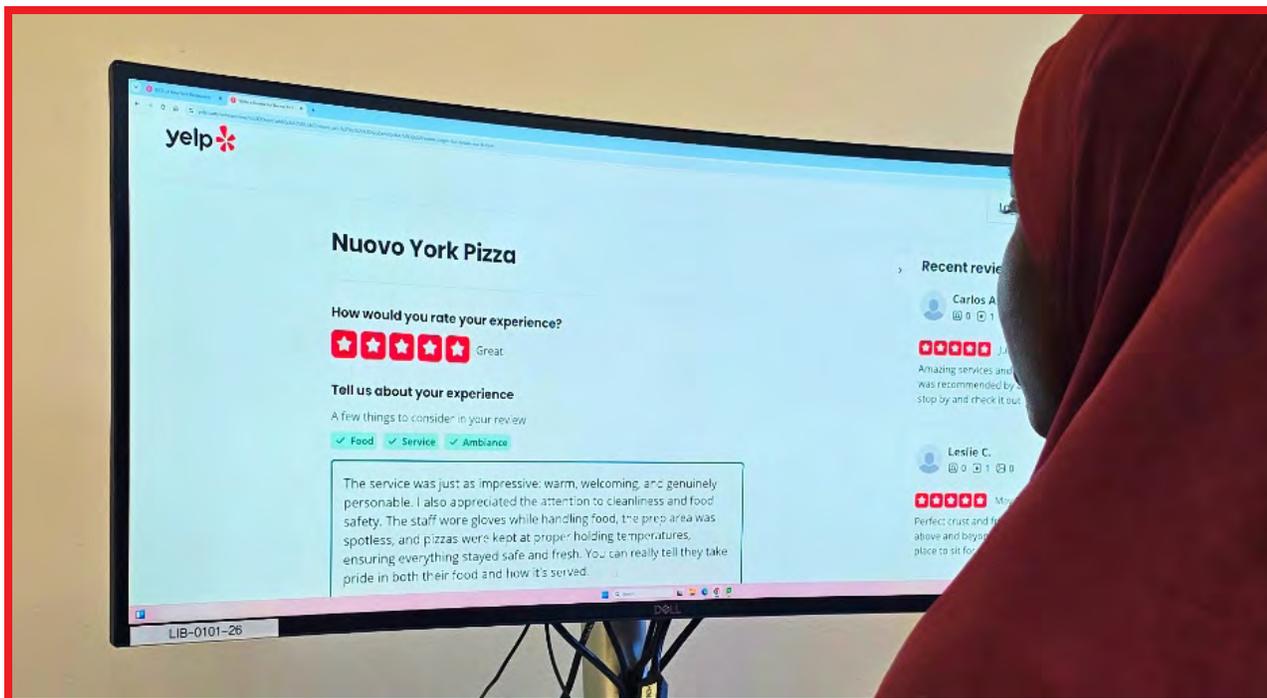
Assessing Restaurant Consumers' Food Safety Comments on Social Media

ABSTRACT

This study analyzed restaurant consumers' food safety-related reviews on social media. The research questions were what: 1) terms do customers use to communicate their food safety concerns, complaints, and satisfaction in online reviews? and 2) are categories of perceived food safety risks? A data collection tool, Yelp Application Programming Interface, was used to search New York City restaurants serving foods commonly consumed and requiring time and temperature control to maintain safety (e.g., salads, burgers). Using Python programming language, researchers collected 273,615 customer reviews from Yelp. Reviews were cleaned, and 276 customers' food safety-related reviews retained within the 3-month study period. Both manual and AI-driven computer-assisted data analysis software were used to analyze customers' food safety reviews. Analysis revealed that different customers used the same terms to communicate different meanings. The findings also included seven themes customers used to communicate their perceptions of food safety in restaurants, including 1) pests and insects, 2) personal hygiene, 3) overall restaurant cleanliness, 4) foreign objects, 5) food temperature, 6) food quality, and 7) allergy concerns. Based on the findings, actions are suggested for restaurant owners and food safety professionals to avert potential unforeseen financial impacts for the business due to negative food safety reviews.

INTRODUCTION

Restaurant industry and food safety

The restaurant industry plays a substantial role in the United States economy (7). Restaurant sales were $966 billion in 2022, $1,049 billion in 2023, and projected to be $1,106 billion in 2024 (33). For continued sales increase, ensuring that the food served to customers is safe for consumption remains paramount. Thus, adherence to food safety practices and mitigating foodborne outbreaks remain a pertinent issue in the foodservice industry. Although sales continue to increase, it is noted that between 2017 and 2019, 81.4% of foodborne illness outbreaks were associated with restaurants (32). These outbreaks may occur due to various reasons, including contamination, food preparation

*Author for correspondence: Phone: +1 515.294.7474; Email: majasa@iastate.edu

practices, or sick employees (16). According to the U.S. Food and Drug Administration Food Code (14), the person in charge is responsible for excluding and restricting sick employees. Arendt et al. (4) suggested the need for consistent communication between managers and employees about health policies to protect consumers from becoming ill.

Food safety is an important factor in customer's dining decisions (28). In 2021, U.S. customers spent an estimated 33.6% of every food dollar at foodservice establishments, including restaurants (44). Customers are willing to pay extra for reduced food safety risks in restaurants (3, 42). In one study (3), researchers found that most participants indicated willingness to pay between 0–30% more for food safety risk reduction (between 25–75% reduction in risk). Despite the willingness to pay extra, consumers inherently expect food to be safe as they assess the food safety level of restaurants to make dining decisions (6).

Similarly, Hodges et al. (17) explored customer-generated online reviews related to foodborne illness and restaurant cleanliness. Hodges et al. (17) found that the frequency of keywords related to foodborne illness and restaurant cleanliness decreased with an increase in restaurant meal prices (17). Also, Hodges et al. (17) suggested using the frequency of foodborne illness keywords in online reviews to improve food safety practices in restaurants.

Social media

The rapid development of social media has provided unprecedented opportunities for consumers to engage and communicate online (11). Reviews posted by previous customers are often perceived by future customers as being more credible and trustworthy than the content posted by businesses (11). Customers frequently post their experiences regarding food safety conditions of restaurants on online review platforms. Based on satisfaction or dissatisfaction, previous customer reviews play a crucial role in helping future customers make dining decisions (7), therein potentially influencing restaurant financial performance (19).

Restaurant reviews

Restaurant reviews may be delivered by traditional word-of-mouth (WOM) or electronic word-of-mouth (eWOM), with the latter being the most common due to technological advancements (18). Restaurant review platforms, such as Yelp, allow customers to comment about their dining experiences to more than a hundred million visitors monthly and help potential customers make restaurant selection decisions (29). Customers use restaurant quality attributes such as service quality, food quality, and restaurant ambiance to form their perceptions of restaurants and provide either positive or negative WOM based on their satisfaction levels (49). A past study indicated that customers post positive eWOM for food taste, restaurant environment, and service but post negative eWOM for food taste, physical environment, and price (49).

Tang et al. (43) found that customers used words on Facebook such as "joy," "trust," and "anticipate" to express their positive sentiments about their dining experience. In contrast, "disgust," fear," and "surprise" were used to communicate negative sentiments. Positive eWOM helps potential customers trust a brand, make purchase decisions, and give the brand a competitive advantage. On the other hand, negative eWOM has a detrimental effect on brand image and is linked with service failure (1). Thus, restaurant managers must consider positive and negative WOM to build customer's trust and ensure a positive brand image.

Food safety and customer reviews

Customers respond to information about food safety postings online (i.e., outbreak information), share the information with friends and families, take action, and post emotional responses and questions based on their risk perceptions (2). In restaurants, customers use several visible and observable cues to form their opinions (28). Restaurant customers perceived that restroom cleanliness showed the overall sanitation of a restaurant (21), and clean restrooms were regarded as one of the most critical factors influencing satisfaction, revisit intention, and positive word of mouth (22). Other visible areas that provided restaurant cleanliness cues included clean serviceware, a clean dining room, and a clean menu (22). Liu and Lee (28) found that customers choose restaurants with good hygiene standards (e.g., clean restrooms, tableware, and serving utensils) rather than restaurants with tasty food at a reasonable price.

The importance of food safety is also resonated with government-led food safety inspection of foodservice operations and the publicly-available inspection results across countries. Visual elements (e.g., face emojis) are used to present food safety inspection reports to customers in Denmark (10) and Finland (12, 46). In contrast, countries like the United Kingdom (15) and Australia (34) use a numeric grading format to present food safety inspection results. In some parts of the United States (e.g., the target location for this study, New York City), the letter grading scale (i.e., A, B, or C) is used to present food safety inspection results to customers (20, 30). Vanio et al. (46) found that the inspection grade influences customers' behavioral intentions to dine at a restaurant, and customers are less likely to patronize a restaurant if they perceive higher food safety risks from inspection reports (46). Unlike inspection reports prepared by food safety experts, customers post their food safety risk perceptions using online review platforms (e.g., Yelp) to express their online evaluations using star ratings (23). Park et al. (39) found that nonchain quick-service restaurants had higher Yelp ratings than chain full-service restaurants. Researchers compared restaurant inspection reports with corresponding star ratings on Yelp and Google reviews (23). They found that restaurants with fewer critical violations tend to have higher star ratings on Yelp and Google

review websites *(23)*, indicating that customer perceptions of food safety risk in restaurants align with food safety inspection reports *(23)*.

Additionally, Nsoesie et al. *(37)* used foodborne illness-related reviews on Yelp to monitor the foodborne illness and outbreak from the CDC. They found that the foods implicated in foodborne illness reported by the CDC correlated with the reviews from Yelp *(37)*. Therefore, customer reviews may provide useful foodborne illness-related information for government agencies.

Impact of customer food safety review on business

Customer WOM impacts the restaurant business, given that restaurants offer experiential products (i.e., foods) that are difficult to evaluate before purchase *(49)*. Yim et al. *(48)* indicated that online customer reviews about the quality of food and services influenced restaurant's online popularity. Positive eWOM increased customers' purchase intention for both strong and weak brands *(47)*. In addition, Wang et al. *(47)* suggested that an increase in the number of reviews (review volume) increases the number of restaurant customers and profitability *(47)*. Also, Kim et al. *(19)* investigated a regional restaurant chain with more than 70 restaurant operations. They found that the number of reviews impacted net sales, guest counts, and average check of the restaurant. Therefore, a positive relationship exists between the number of reviews and restaurant financial performance *(19)*.

Online review ratings are also reported to impact restaurant revenue positively *(29)*. Luca *(29)* noted that a one-star increase in restaurant customer rating on Yelp leads to a 5-9% increase in revenue. Given the importance of online reviews, restaurateurs may benefit by improving their food safety practices and keeping high restaurant ratings, as higher ratings increase revenue and generate a higher return on investment *(19)*. While monitoring and enforcing food safety practices by state and local health departments are one motivator for restaurateurs as a potential negative consequence, the benefits to bottom-line financials may be a positive motivator for prioritizing food safety practices.

Therefore, the purpose of this study was to 1) identify the terms customers used to communicate food safety concerns, complaints, and satisfaction in their online reviews and 2) investigate what categories of food safety risks are perceived by customers. Although restaurant customer reviews and their attributes have been extensively investigated in previous studies, research has yet to be done analyzing restaurant customers' food safety-related reviews on social media platforms. This study, therefore, aimed to fill that gap by using a qualitative approach to understand restaurant consumer perceptions of food safety posted on an online review platform, Yelp. Reviews from restaurants serving food that require time and temperature control for safety (TCS) within New York City (NYC) were used in this study. Specifically, the research questions were as follows:

1. What terms do customers use to communicate their food safety concerns, complaints, and satisfaction in their online reviews?
2. What categories of food safety risks are perceived by customers?

This study's novelty lies in being the first to comprehensively assess customer food safety reviews to generate insights for restaurateurs and food safety professionals to improve restaurant food safety practices. In addition, this study utilized a manual analysis and an AI-driven analysis tool, NVivo, to analyze customer reviews. This novel approach may assist food safety researchers in utilizing artificial intelligence-based programs to analyze qualitative data and provide insights for restaurateurs and foodservice professionals on how customers communicate their food safety concerns and respond accordingly to prevent unforeseen financial implications.

MATERIALS AND METHODS

Sample selection

New York City (NYC) was selected as the study area for several reasons. First, the restaurant industry in NYC is one of the largest and fastest-growing industries in the United States *(38)*. It is also a food tourism destination that offered global cuisines to 56.7 million visitors in 2022 *(35)*, and visitors spent an estimated $46 billion annually *(38)*. The food safety condition of a restaurant is essential in tourists' destination selection *(26, 40)*. Therefore, this study focused on all NYC restaurants serving foods requiring time and temperature control for safety (TCS) ; those were selected from Yelp categories of salads, delis, seafood, burgers, and tacos.

Data collection

The data collection period was from June 1, 2022, to August 31, 2022. The study period was selected because it is peak tourism season in NYC *(45)*. Customer reviews from NYC restaurants posted on Yelp were collected using Python. Yelp Application Programming Interface (API) was used to search for restaurants, using the location keyword, 'New York City,' and the categories keyword, 'salads,' 'delis,' 'seafood,' 'burgers,' and 'tacos'. All collected reviews were then manually assessed for posted date to select those reviews in the study period as Yelp API did not allow for selecting reviews within a certain date ranges.

In total, 273,615 reviews were collected and manually cleaned. Of these reviews collected, 268,200 were outside the study period (June 1, 2022–August 31, 2022), and excluded, leaving 5,415 reviews. Furthermore, 5,139 reviews were excluded from the dataset as they were not food safety-related reviews (e.g., reviews related to service quality, information quality, order quality, and timeliness quality), leaving only food safety-related reviews (e.g., reviews relating to food quality). In total, 276 food safety-related reviews remained included in the final dataset for analysis from 199 restaurants. *(Fig. 1)*.
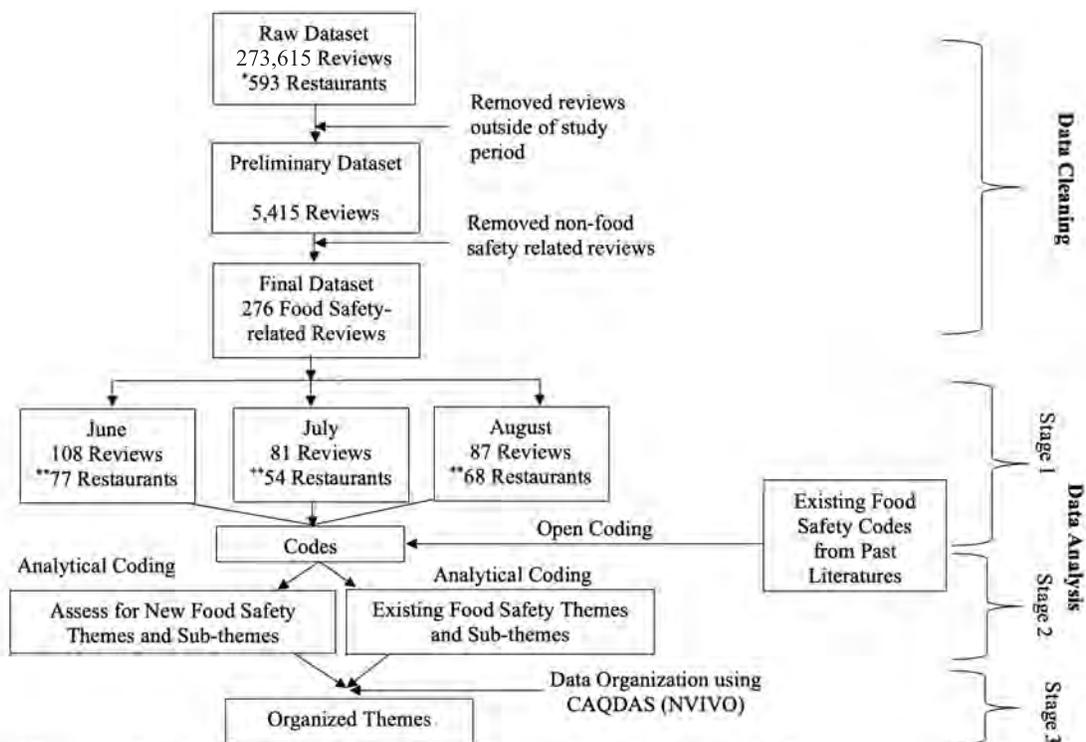
Figure 1. Data cleaning and analysis stages.

Data analysis

Researchers analyzed the final dataset to identify customers' terms for communicating their concerns, complaints, and satisfaction in online reviews. Similar to the process identified by Merriam and Tisdell *(31)*, researchers employed a phenomenological approach, which studies people's shared experiences, to analyze the data. As such, researchers read entire reviews to gain insight into the customer's experiences and then categorized reviews accordingly. In addition, by employing a strategy called bracketing, where prior opinions or views are temporarily set aside *(31)*, researchers gained a better understanding of individuals' experiences and extended their objective comprehension of the phenomenon of interest *(31)*. Therefore, researchers' analysis of reviewers' experiences were solely based on the insight gained from interpreting and understanding the customer's experiences. Researchers employed this strategy to recognize the essence of customers' terms in communicating concerns, complaints, and satisfaction.

To address the second research question, researchers employed three stages for data analysis *(Fig.1)*. The first stage involved the method used in past studies *(24, 25)* to gather an initial list of food safety items from existing food safety literature (e.g., *(6)* and *(28)*). Examples of these items

included: foreign object found in food or drink *(6)* and clean utensils *(28)*. The second stage used the list to capture texts aligned with the terms, which were then coded for analysis. The second stage was similar to the process used by Alban et al. *(2)* and in alignment with the process identified by Merriam and Tisdell *(31)*. At this second stage, researchers read the final dataset (i.e., food safety reviews) line-by-line to get familiar with the text, utilized manual analysis to label the text with various codes aligned from the first stage, and grouped text segments by themes and sub-themes. Some text segments aligned with multiple codes and were represented more than once.

The third stage involved further analysis using a computer-assisted data analytics software (CAQDAS), NVivo. NVivo is an artificial intelligence (AI) driven tool that not only confirmed manual analysis but utilized advanced algorithms and machine learning capabilities to provide a deeper understanding of the interrelationships between codes.

RESULTS

Terms communicating food safety concerns, complaints, and satisfaction

In total researchers analyzed 276 customer food safety-related reviews on Yelp. Using a phenomenological

approach, the study uncovered the terms customers used to communicate their food safety concerns, complaints, and satisfaction in online reviews. To communicate food safety concerns, customers used 'questionable' and 'poorly managed' (each word appeared once). They also used 'fishy' (appeared seven times), 'old taste' (appeared three times), 'cold' (appeared fourteen times), 'slimy' (appeared two times), and 'disgusting' (appeared four times) to express their complaints. To communicate satisfaction, they used 'piping hot' (appeared four times), 'welcoming' (appeared five times), 'maintained' (appeared two times), and 'pleasant' (appeared two times). While restaurant owners may easily understand some of these terms, the term 'fishy' may not be easily understood as different customers use it in different contexts to communicate different meanings. An example review where customers used the term is as follows:

"…while I was excited to try the crab and pork soup dumpling, the crab had a strong fishy taste, so I unfortunately didn't enjoy them…"

Researchers utilized the bracketing strategy to analyze the review above to understand the essence of the term 'fishy' in this context as 'not fresh.' Whereas, in the review below, the term was used differently to communicate positively about the seafood.

"They have an oyster bar, and you can tell it all is very fresh. Nice, light, and fishy…"

Thus, the terms customers use in one context may be used to communicate a different meaning in another context.

Customer food safety risk perceptions in online reviews

A total of seven themes *(Table 1)* were identified as the food safety risk aspects perceived by customers in restaurants, including 1) allergy concerns, 2) food quality, 3) food temperature, 4) foreign objects, 5) overall restaurant cleanliness, 6) personal hygiene, and 7) pests and insects.

The most frequent themes were "food quality" (207 text segments) and "overall restaurant cleanliness" (102 text segments). The most frequent code references under these themes were fresh food (136 text segments), clean interior and outdoor (54 text segments), and restroom cleanliness (32 text segments), respectively. Example review content for each theme is presented as follows.

Allergy concerns: Comments regarding allergy concerns were often related to cross-contact. Customers appreciated restaurant employees who gave attention to their allergy concerns and regarded restaurant employees who lacked attention to their allergy concerns as a risk to life. Examples of review content included:

"…The staff really goes beyond and above for their customers- was dining with a friend with celiac and the waitress ensured that their allergies were noted…"

"…I told the waiter that I had a health condition and couldn't have that starch in my food. They took the food back and returned it with mashed potatoes on the side but had just plated it separately with the same meat. I had to wipe it down with my napkin and still ended up getting very sick. For those with more serious allergies, this could be a serious risk to life…"

Food quality: Customers commented on the restaurant's food quality. They gave positive reviews for fresh, clean, and perfectly cooked food; negative reviews were about not fresh, dirty, raw, undercooked food, and food poisoning. "Fresh" was primarily associated with food smell, taste, and appearance. Examples of review content included:

"…They (oysters) were very fresh and delicious with a nice ocean aftertaste. They were also very clean with no sand or shell bits in there at all…"

"… All dishes were fresh and excellent! I am not surprised that the restaurant was crowded and others around were empty. Care and a high quality and attentive service go a long way..."

"… Food poisoning. Yes - the pastrami meat does taste good and is juicy. But we ended up getting sick because of it. It really breaks my heart to see my wife and kids vomiting up their food, especially when the days of vacation are so precious…"

Food temperature: Customers paid attention to food temperature and gave positive and negative reviews about hot, cold/warm food, respectively. Foods described as hot were those served at the appropriate serving temperature while those described as cold or warm were served at an inappropriate serving temperature. Examples of review content included:

"…This place is such a hidden gem!!! All the food tastes delicious and authentic. It's real soul food that comes to your table freshly made and piping hot…"

"…We came for a birthday celebration and everyone's food was cold…"

"… Now about the food, my husband and I ordered the xxx breakfast and sausages, and bacon was lukewarm. Nothing on our plate was hot…. Worst part was the lukewarm corn beef hash…"

"… How can you fry chicken and still have it warm on the inside. I can almost guarantee the chicken wasn't cooked thoroughly. My stomach is turning over right now…"

Foreign objects: Customers wrote negative reviews when they found unexpected objects in their food. Foreign objects, such as hair, provided evidence that food handlers may not have worn hair restraints, thus increasing the chances of food contamination. Examples of review content included:

"…The food was okay, but I found a hair, which is half white and black, in the fried calamari.

"…The oysters were very sandy, pls clean them properly…"

"…The oysters were fresh, but some of them still had sand/ debris in them that we had to spit out which ruined the experience…"

Overall restaurant cleanliness: Customers observed the cleanliness of the interior and exterior of the restaurant environment, including food and non-food contact surfaces. Examples of positive and negative review content included:

"…The restaurant is so bright and festive it feels like you have magically landed in the Caribbean. It's like being at Grandma's house for dinner-- clean, warm, intimate, and welcoming…"

TABLE 1. Themes, sub-theme, and codes of food safety-related reviews

Themes	Description	Codes	Example Quotes	Frequency of Text Segments
Allergy concerns	Any statement about customer's allergic concern			7
		Negative attention to allergy concerns	"...I am vegan and have a severe allergy to all onion and garlic and told my server… and promised there wasn't any in the spring rolls. 15 minutes later I was sick and had to run home to take medication..."	5
		Positive attention to allergy concerns	"…The staff really goes beyond and above for their customers- was dining with a friend with celiac and the waitress ensured that their allergies were noted…"	2
Food quality				207
	Any statement about the freshness of food	Fresh food	"…No fishy smells, taste, or oceanic debris found in any of what we ate. Everything was super fresh..."	136
		Not fresh food	"...the biggest problem on the plate was definitely the salad … the greens were long past its prime and rotting..."	28
	Any statement about perfectly or undercooked food	Perfectly cooked food	"… Friendly and professional service…Very clean and food was cooked perfectly…"	26
	Any statement about the food quality	Raw food served	"...They served us complete raw pork soup dumplings… not just undercooked..."	1
	Any statement about perfectly or undercooked food	Undercooked food	"... the salmon was not cooked all the way through, and we had to send it back. We heard the diners next to use complain about how terrible the food was …"	1
	Any statement about the presence of dirty or debris and how clean the seafood is	Dirty seafood	"… Everything was amazing… except the happy hour oysters. They came dirty I had to send them back …"	3

TABLE 1. Themes, sub-theme, and codes of food safety-related reviews (cont.)

Themes	Description	Codes	Example Quotes	Frequency of Text Segments
Food quality	Any statement about the presence of dirty or debris and how clean the seafood is	Clean seafood	"…The oysters were very fresh and delicious…They were also very clean with no sand or shell bits in there…"	6
	Any statement about sickness after eating	Food poisoning	"…The pastrami meat tasted good and is juicy, but we ended up getting sick because of it..."	6
				37
Food temperature	Any statement about customers comment on the food temperature	Cold food	"…We came for a birthday celebration and everyone's food was cold…"	15
		Hot food	"… All the food tastes delicious and authentic. It's real soul food … freshly made and piping hot…"	17
		Warm food	"…I ordered the xyz breakfast and sausages, and bacon were lukewarm. Nothing on our plate was hot…"	5
				5
Foreign objects	Any statement about the presence of hair or sand in food	Sand in food	"…The oysters were fresh, but … still had sand/debris in them that we had to spit out which ruined the experience…"	3
		Hair in food	"…The food was okay, but I found a hair, which is half white and black, in the fried calamari…"	2
				102
Overall restaurant cleanliness	Any statement about cleanliness of the interior and exterior	Clean interior and outdoor	"…the interior is clean, and the staff is friendly…"	54
		Dirty interior and exterior	"…We sat outdoors and … there were a lot of flies and even a dead roach on the structure we sat on which was a huge turn off for the food..."	4

Themes	Description	Codes	Example Quotes	Frequency of Text Segments
Overall restaurant cleanliness	Any statement about kitchen cleanliness	Clean kitchen	"… I was very pleased to see the bathroom and a quick peek at the kitchen was clean …"	1
		Dirty kitchen	"…It was such a huge disappointment that the kitchen wasn't clean enough …"	2
	Any statement about cleanliness of the tables and floors	Clean table	"…This spot was great … clean table …"	3
		Dirty table and floors	"…I was more disappointed by the lack of care in keeping the tables and floors clean after people left their tables …"	2
	Any statement about cleanliness of the service ware	Dirty serviceware	"…The teapot and the utensils were dirty; the whole place is not clean. I would never go here again..."	4
Overall restaurant cleanliness*	Any statement about bathroom cleanliness and bathroom supplies	Clean restroom	"...the bathroom was extremely clean … It shows the overall cleanliness of the restaurant …"	21
		Dirty restroom	"…The bathroom had a cool neon light, … but clearly very dirty …"	8
		Restroom hygiene supplies	"…dirty bathroom with absolutely no hand dryer, or napkins to dry your hands …"	3
Personal hygiene	Any statement about hygiene of restaurant staff	Personal hygiene	"…the manager was standing there talking to his friends and smoking a cigar. People were eating while smelling the smoke from the cigar…"	1
Pests and insects	Any statement about the presence of pests or insects in the restaurant	Pests and insects	"…This restaurant is beyond disgusting…They sit people next to garbage and mice...."	3

*Overall restaurant cleanliness had one sub-theme - Restroom cleanliness

"… service was unnecessarily slow, but I was more disappointed by the lack of care in keeping the tables and floors clean after people left their tables…"

"…This is rather cute classic looking deli that I happened upon. I was a little hungry, so I figure why not It is well lit and clean…"

"…The teapot and the utensils were dirty; the whole place is not clean. I would never go here again…"

Most importantly, some customers perceived that a clean bathroom indicated the restaurant's cleanliness. They also believed that the availability of restroom hygiene supplies contributed to restroom cleanliness and appreciated paper towels and hand dryers. Examples of review content included:

"…this is small, but the bathroom was extremely clean. I am funny about that kind of thing as it shows the overall cleanliness of the restaurant…"

"… Feels like a cool hidden situation. But the bathroom is clean, paper towels are nice and thick, I was a fan…"

"…very clean considering this is New York, I was very pleased to see the bathroom…"

"… awful dirty bathroom, with absolutely no hand dryer, or napkins to dry your hands…

Personal hygiene: Some customer comments related to personal hygiene involved their observations about the appearance or behavior of restaurant employees. An example of review content included:

"… All the tables around us were covered in plates, nobody cleaning tables and this manager was standing there talking to his friends and smoking a cigar. People were eating while smelling the smoke from the cigar. It was nasty…"

According to the U.S. Food and Drug Administration (FDA, 2021) Food Code, an employee should not eat, drink, or use any form of tobacco in areas where the contamination of exposed food, utensils, and other items needing protection can result (14).

Pests and insects: A customer wrote a negative review about a restaurant having pests like mice and linked cases of food poisoning from past reviews with mice inside the restaurant. The reviewer also recognized the impact of this violation on the restaurant but the manager believed that preventing pest issues was out of control. While dining outdoors, another customer also noted the presence of other pests and flies. However, this is expected in an outdoor dining setting, but there are control measures that could be applied to reduce such issues. Examples of review content included:

"… So, I've read through the reviews from other patrons, and I noticed that a good amount of people have gotten food poisoning …While seated I saw little Mickey Mouse ears... I asked our server for the manager and when he arrived, I told him that... He was immediately dismissive about it and stated, "well we share this roof with other people so we can't control that"… I made him aware that what he was saying was incorrect... I know several health inspectors, and I know for a fact this can potentially shut a restaurant down…"

"…We sat outdoors and while it was nice …, there were a lot of flies and even a dead roach on the structure we sat on which was a huge turn off for the food. However, that is Mother Nature and not the restaurants' fault, so I am not considering it as part of my review…"

DISCUSSION

This study analyzed the words customers used to communicate their food safety concerns, complaints, and satisfaction in online reviews, as well as the categories of food safety risks perceived by customers. The findings revealed that customers used terms like 'questionable' and 'poorly managed' to communicate concerns; 'fishy,' 'old taste,' 'cold,' 'slimy,' and 'disgusting' to express complaints; and 'piping hot,' 'welcoming,' 'maintained,' and 'pleasant' to convey satisfaction. Restaurant owners can use the terms uncovered in this study to inform employees managing their social media accounts about the language customers use online. This knowledge enables appropriate responses, fosters complaint resolution, helps preserve the business's online reputation, and prevents unforeseen financial implications for the business.

Additionally, the study found that customers perceive food safety risks in restaurants using allergy concerns, food quality, food temperature, foreign objects, overall restaurant cleanliness, personal hygiene, pests, and insects. Customer reviews expressed both appreciation and concern about the level of attention that restaurant employees gave to their allergies.

Establishing proper communication among customers, service staff, and kitchen staff, as well as including advisories or food allergy information in menus, may help to reduce food safety concerns in restaurants. Restaurant owners and food safety professionals (e.g., quality assurance managers) may also train kitchen and service staff about the major food allergens. Placa (41) found that most Florida restaurants (n = 63 of 103) had no written policies and procedures on food allergies. However, some states, like Massachusetts, have restaurant allergy awareness laws that require all restaurants to include a notice on menus (13). Additionally, managers must have both the food protection manager certificate and the Massachusetts certificate of allergen awareness (13). While New York City (NYC) restaurants are required to post information on food allergies (13), there appears to be a lack of food allergy knowledge among servers based on the Yelp reviews analyzed in this study. Therefore, it may be beneficial for NYC restaurants to implement employee food allergy training to reduce negative reviews and the risk of customers experiencing an allergic reaction. A recent study by Lee and Wei (27) revealed that customers believed that food allergen information on the menu showed that a restaurant was safe, and they would revisit the restaurant, recommend it to friends, and give positive comments (27).

Customer perceptions of food safety risks in restaurants may impact their revisit intentions. Bai et al. (6) indicated

that the sensory perceptions of food, such as whether the food looked fresh and customers felt sick after eating, were the most significant indicators used by customers to assess restaurant food safety levels. Similarly, customer reviews analyzed in this study revealed that customers frequently used food quality attributes (e.g., freshness of food, food poisoning, and thoroughly cooked food) to form their food safety risk perception of restaurants. Food may taste and smell fresh but may not be prepared under safe conditions, potentially making customers sick. Other contributing factors causing food poisoning in restaurants include inadequate hand washing by food handlers, cross-contamination between products, or contamination from sick employees, (16). Arendt et al. (4) suggested that managers frequently communicate with employees to take responsibility for reporting illness to prevent the spread of foodborne diseases.

Regarding pests and insects, one remarkable review indicated that the customer appears to know the details in food safety inspection reports and how health inspectors will likely react to certain food safety violations like pest issues. Pest issues in restaurants are critical and may influence customer's revisit intentions. This finding suggests a call for action for restaurant owners and food safety professionals to work closely with pest control professionals to mitigate restaurant pest issues. Since motivators such as internal (e.g., desire not to make someone sick) and external (e.g., punishment) motivators were found to enhance safety practices in restaurants (5), the fear of punishment from the regulatory authority may be one motivator for food safety compliance in restaurants. Restaurant owners and food safety professionals may consider the impact of noncompliance on revenue generation as an additional motivation for compliance. Restaurant owners' attention to improving food safety may enhance positive eWOM, which can generate higher revenues for the business, while employees might be more motivated by the potential for larger tips (36).

In conclusion, this study analyzed restaurant consumers' food safety comments on social media. The study identified the terminology customers used in their online reviews and analyzed the meanings behind these words. Additionally, the study found seven aspects that form customers' perceptions of food safety in restaurants. These findings suggest the importance of prioritizing food safety practices for restaurant owners and food safety professionals to encourage positive social media feedback. Considering the potential impact of positive reviews on customer volume and expected revenue, there is a strong motivation for restaurant owners and food safety professionals to prioritize food safety practices.

This research has limitations and presents suggestions for future research. First, researchers relied on an initial list of food safety codes from existing food safety-related literature, which may have introduced a potential source of bias, limiting researchers to pre-existing codes and possible exploration of emerging themes. Future studies could implement additional approaches to guard against potential biases, such that an inductive mode of data analysis is utilized at the beginning of theme construction rather than a deductive mode (31). Second, because the study collected positive and negative reviews, interesting insights may have been generated if researchers determined the relationship between the sentiment type of review (i.e., positive or negative) and overall restaurant rating. Future studies could also explore the impact of effective managerial responses to reviews on customer return intention and subsequent restaurant's financial performance and inspection scores. Third, because the study included reviews from all types of restaurants selling TCS foods, it might provide more insight if researchers had analyzed the reviews based on quick service, limited service, and full-service restaurants. Lastly, future studies could compare customer online reviews with restaurant inspection reports to identify similarities. This could show how restaurant owners and food safety professionals could use customer reviews and perceptions to self-evaluate their operations before a health inspection.

REFERENCES

1. Ahmad, F. and F. Guzmán. 2021. Negative online reviews, brand equity, and emotional contagion. *Eur. J. Mark.* 55:2825–2870.

2. Alban, M., M. Pomeroy, N. J. Sood, and K. E. Marshal. 2022. A qualitative content analysis of responses to CDC's foodborne outbreak messages on Facebook. *Food Prot. Trends* 42:174–185.

3. Alphonce, R., F. Alfnes, and A. Sharma. 2014. Consumer vs. citizen willingness to pay for restaurant food safety. *Food Policy.* 49:160–166.

4. Arendt, S. W., Y. Xu, M. S. Miklos, E. A. Nutt, and S. Mandernach. 2024. Assessing employee health policies and practices in foodservice establishments. *Food Prot. Trends.* 44:260–272.

5. Arendt, S. W., C. Strohbehn, and J. Jun. 2015. Motivators and barriers to safe food practices: Observation and interview. *Food Prot. Trends.* 35:365–376.

6. Bai, L., M. Wang, Y. Yang, and G. Shouliang. 2019. Food safety in restaurants: The consumer perspective. *Int. J. Hos. Manag.* 77:139–146.

7. Bilgihan, A., S. Seo, and J. Choi. 2018. Identifying restaurant satisfiers and dissatisfiers: Suggestions from online reviews. *J. Hosp. Mkt. Manag.* 27:601–625.

8. Bushara, M. A., A. H. Abdou, T. H. Hassan, A. E. E. Sobaih, A. S. M. Albohnayh, W. G. Alshammari, M. Aldoreeb, A. A. Elsaed, and M. A. Elsaied. 2023. Power of social media marketing: How perceived value mediates the impact on restaurant followers' purchase intention, willingness to pay a premium price, and E-WoM. *Sustainability.* 15:5331.

9. Carpenter, L. R., A. L. Green, D. M. Norton, R. Frick, M. Tobin-D'Angelo, D. W. Reimann, H. Blade, D. C. Nicholas, J. S. Egan, K. Everstine, L. G. Brown, and B. Le. 2013. Food worker experiences with and beliefs about working while ill. *J. Food Prot.* 76:2146–2154.

10. Danish Veterinary and Food Administration (DVFA). 2019. About the Danish Smiley Scheme. Ministry of Environment and Food of Denmark. Available at: https://www.findsmile y.dk/english/Pages/About.aspx. Accessed 1 May 2024.

11. Filieri, R., S. Alguezaui, and F. McLeay. 2015. Why do travelers trust TripAdvisor? Antecedents of trust towards consumer-generated media and its influence on recommendation adoption and word of mouth. *Tour. Manag*, 51:174–185.

12. Finnish Food Authority. 2018. Food safety in Finland 2017. Available at: https://www.ruokavirasto.fi/globalassets/tietoa-meista/julkai sut/julkaisusarjat/julkaisuja/en/eviran_julkaisuja_4_2018_uk_310818.pdf. Accessed 1 May 2024.

13. Food Allergy Research and Education (FARE). 2022, Food Allergies and Restaurants, Available at: https://www.foodallergy.org/resources/food-allergies-and-restaurants. Accessed 5 May 2024.

14. Food and Drug Administration (FDA). 2022. Food Code. Available at https://www.fda.gov/media/164194/download?attachment. Accessed 16 May 2024.

15. Food Standards Agency. 2017. Food hygiene rating scheme (FHRS) biannual public attitudes tracker. UK: Food Standards Agency. Available at: https://www.food.gov.uk/sites/default/files/media/document/fhrstracker-wave5report_1_0.pdf.

16. Gould, L. H., I. D. A. Rosenblum, D. Nicholas, Q. Phan, and T. F. Jones. 2013. Contributing factors in restaurant-associated foodborne disease outbreaks, FoodNet sites, 2006 and 2007. *J. Food Prot*. 76:1824–1828.

17. Hodges, J. R., M. Lee, A. DeFranco, and S. A. Sirsat. 2022. Exploring Foodborne Illness and Restaurant Cleanliness Reporting in Customer-Generated Online Reviews Using Business Analytics. *J. Environ. Health* 85:3

18. Jalilvand, M. R., S. Salimipour, M. Elyasi, and M. Mohammadi. 2017. Factors influencing word of mouth behavior in the restaurant industry. *Mkt Intel. Plan*. 35: 81–110.

19. Kim, W. G., J. J. Li, and R. A. Brymer. 2016. The impact of social media reviews on restaurant performance: The moderating role of excellence certificate. *Int. J. Hosp. Manag*. 55:41–51.

20. Kim, M. G., H. Yang, and A. S. Mattila. 2017. The impact of customer loyalty and restaurant sanitation grades on revisit intention and the importance of narrative information: The case of New York Restaurant sanitation grading System. *Cornell Hosp. Q*. 59:275–284.

21. Kim, H., and J. R. Bachman. 2019. Examining customer perceptions of restaurant restroom cleanliness and their impact on satisfaction and intent to return. *J. Foodserv. Bus. Res*. 22:191–208.

22. Kim, T. J., B. Almanza, J. Ma, H. Park, and S. F. Kline. 2021. The cleanliness of restaurants: ATP tests (reality) vs consumers' perception. *Int. J. Cont. Hosp. Manag*. 33:893–911.

23. Kong, E., and H. Heacock. 2020. Comparison of restaurant inspection report results and its corresponding star ratings on Yelp and Google Reviews. *BCIT Environ. Pub. Health. J*.

24. Le, T. H., C. Arcodia, M. A. Novais, and A. Kralj. 2021. Proposing a systematic approach for integrating traditional research methods into machine learning in text analytics in tourism and hospitality. *Curr. Issues Tour*. 24:1640–1655.

25. Le, T. H., C. Arcodia, M. A. Novais, A. Kralj, and T. C. Phan. 2021. Exploring the multi-dimensionality of authenticity in dining experiences using online reviews. *Tour. Manag*. 85:104292.

26. Lee, Y., L. Pennington-Gray, and J. Kim. 2019. Does location matter? Exploring the spatial patterns of food safety in a tourism destination. *Tour. Manag*. 71:18–33.

27. Lee, Y. M., and C. Wei. 2024. Consumer visual attention to food allergen information on restaurant menus: An eye-tracking study. *Br. Food J*.

28. Liu, P., and Y. M. Lee. 2018. An investigation of consumers' perception of food safety in the restaurants. *Int. J. Hosp. Manag*.73:29–35.

29. Luca, M. 2016. Reviews, reputation, and revenue: The case of Yelp. com. *Har. Bus. Sch. Work. Pap*. (12-016). https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.hbs.edu%2Ffaculty%2Fpages%2Fdownload.aspx%3F-name%3D12-016.pdf;h=repec:hbs:wpa-per:12-016.

30. McKelvey, W., M. R. Wong, and B. Matis. 2015. Letter grading and transparency promote restaurant food safety in New York City. *J. Environ. Health*. 78: 46–48.

31. Merriam, S. B., and E. J. Tisdell. 2015. *Qualitative research: A Guide to Design and Implementation*. (4th ed., pp. 204–206). Jossey-Bass.

32. Moritz, E. D., S. D. Ebrahim-Zadeh, B. Wittry, M. M. Holst, B. Daise, A. Zern, T. Taylor, A. Kramer, and L. G. Brown. 2023. Foodborne illness outbreaks at retail food establishments — National Environmental Assessment Reporting System, 25 state and local health departments, 2017–2019. *MMWR Surveill. Summ*. 72:1–11.

33. National Restaurant Association (NRA). 2024. State of the restaurant industry 2024. Available at https://cdn.ymaws.com/www.krha.org/resource/resmgr/2024-State-of-the-Restaurant.pdf. Accessed 20 March 2024.

34. New South Wales Food Authority. 2021. Scores on doors. Consumer guide. New South Wales Food Authority. Available at: https://www.foodauthority.nsw.gov.au/retail/s cores-on-doors/consumer-guide. Accessed 1 May 2024.

35. New York City Tourism + Conventions. 2023. NYC Travel and Tourism Outlook Available at https://assets.ctfassets.net/1aemqu6a6t65/2Y-8QEeyL0WPqNNSp2PF4tb/101bf1f52b3a6a-530beca022c73526c5/2023_Travel__Tourism_Outlook_July_Update.pdf. Accessed 20 March 2024.

36. Norris, C., S. Taylor Jr, and D. C. Taylor. 2024. Just the tip: Exploring the tipped restaurant employee perspective. *Int. Hosp Rev*. 38: 221–238.

37. Nsoesie, E. O., S. A. Kluberg, and J. S. Brownstein. 2014. Online reports of foodborne illness capture foods implicated in official foodborne outbreak reports. *Prev Med*. 67:264–269.

38. Office of the New York State Comptroller. 2020. The restaurant industry in New York City: Tracking the recovery. Available at https://www.osc.ny.gov/files/reports/osdc/pdf/nyc-restaurant-industry-final.pdf. Accessed 20 March 2024.

39. Park, H., J. Kim, and B. Almanza. 2016. Yelp versus inspection reports: Is quality correlated with sanitation in retail food facilities? *PubMed*. 78: 8–12.

40. Pezenka, I. and C. Weismayer. 2020. Which factors influence locals' and visitors' overall restaurant evaluations? *Int. J. Cont. Hosp. Manag*. 32:2793–2812.

41. Placa, N. M. 2021. Food allergy policies, procedures, motivators, and barriers related to following food allergy practices in Metro Orlando restaurants (Doctoral dissertation, Iowa State University). ProQuest Dissertations and Theses Global.

42. Sharma, A., J. Sneed, and S. Beattie. 2012. Willingness to pay for safer foods in food-service establishments. *J. Foodserv. Bus. Res*.15:101–116.

43. Tang, L., X. Wang, E. Kim, and Y. Luo. 2022. What do customers share about eating-out on Facebook? *Adv. Hosp. Tour. Res*. (AHTR). 10:448–479.

44. United States Department of Agriculture (USDA). 2022. Foodservice industry. Available at https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?char-tId=58354. Accessed 21 March 2024.

45. U.S. News & World Report. 2023. New York City Travel Guide. Available at https://travel.usnews.com/New_York_NY/When_To_Visit/. Accessed 20 March 2024.

46. Vainio, A., J. Kaskela, E. Finell, S. Ollila, and J. Lundén. 2020. Consumer perceptions raised by the food safety inspection report: Does the smiley communicate a food safety risk? *Food Control*, 110:106976.

47. Wang, Y., J. Kim, and J. Kim. 2021. The financial impact of online customer reviews in the restaurant industry: A moderating effect of brand equity. *Int. J. Hosp. Manag*. 95:102895.

48. Yim, E. S., S. Lee, and W. G. Kim. 2014. Determinants of a restaurant average meal price: An application of the hedonic pricing model. *Int. J. Hosp. Manag*. 39:11–20.

49. Zhang, Z., Z. Zhang, and R. Law. 2014. Positive and negative word of mouth about restaurants: Exploring the asymmetric impact of the performance of attributes. *Asia Pac. J. Tour. Res*. 19:162–180.