Calorie and Carbon Labels on Menus in Chinese Restaurants: Effects of Label Presence and Presentation Format on Customer Behavior and Brand Perceptions

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for
Journal of Travel & Tourism Marketing
publication consideration

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Abstract

This study employed a 2 (calorie and carbon emission) × 2 (numeric and reference) experimental design to assess the impact of displaying nutritional and environmental information on menus in hotel's Chinese restaurant. Unlike previous studies primarily focused on simulated intention, it captured consumer actual behavior and perception. While such information did not significantly affect dietary choices, the inclusion of carbon emission information had a positive influence on perceived social responsibility. The reference format proved effective in enhancing transparency, especially when the information was complex. This research offers practical insights for restaurants to effectively communicate their commitment to health and sustainability.

Keywords: Calories, Carbon emission, Chinese Restaurant, Communication, Dietary Choice, Hotel, Life Cycle Analysis, Menu, Social Responsibility, Transparency

1. Introduction

ESG (Environmental, Social, and Governance) management is the foremost sustainable priority in the hospitality and tourism industry (Choi & Choi, 2024), doubling as a strategic tool to enhance brand image, reputation, and financial outcomes (Lee *et al.*, 2024). Thus, hotels and restaurants are increasingly mindful of their responsibility towards global population health and the environment. This is supported by the fact that a company's engagement in socially responsible behaviors influences customers' patronage decision (Quan et al., 2022).

A well-designed restaurant menu can educate customers and influence their purchasing decisions (Kozup *et al*., 2003). While calorie information is typically associated with diet and health, carbon emission information is gaining prominence as individuals become more environmentally conscious. Mandatory calorie labeling has been implemented in various countries for large food businesses or chain restaurants, including the United Kingdom, United States, parts of Australia, and South Korea (Cleveland *et al*., 2020; Jeacle & Carter, 2023). Meanwhile, voluntary schemes for such labeling are observed in New Zealand, Ireland, Japan, and Singapore (Health Promotion Board, 2020; Ministry for Primary Industries, 2022). In addition, some restaurants voluntarily disclose the carbon footprint of each dish on menus, aiding customers in evaluating the environmental impact of their food choices (Kateman, 2020). However, it remains uncommon to find such information provided in Chinese restaurants.

Being socially responsible and transparent are crucial in enhancing a company's competitive advantages and demonstrate its commitment in ESG and corporate social responsibility (CSR). Embracing ESG management and CSR initiatives enables restaurants to meet consumers' societal and ethical expectations, make meaningful contributions to society, and cultivate customer loyalty. Sharing environmental and nutritional information allows restaurants to positively impact society, address environmental issues, promote sustainability, and prioritize customer well-being. The COVID-19 pandemic has further heightened consumer awareness of the importance of healthy eating, making transparency about ingredients and the impact of food products on health and the environment even more critical (AlTarrah *et al.*, 2021; Shi *et al.*, 2020). By being transparent and ethical, restaurants can establish trust, enhance customer satisfaction, and foster long-term loyalty (Filimonau & Krivcova, 2017). In doing so, they not only contribute to a more sustainable future but also meet the evolving needs of their customers.

Earlier studies investigating the effects of menu labeling in restaurants have primarily centered on consumers' simulated intentions rather than their actual behavior (Papaoikonomou *et al.*, 2011). Several experimental studies have examined how displaying health-related and environmental information on menus affects consumer choices in different types of restaurants, such as fast food, casual dining, and buffets (Filimonau *et al.*, 2017a, 2017b; Gossling *et al*., 2011; Pulkkinen *et al*., 2016; Spaargaren *et al*., 2013). Although consumers generally respond positively to the inclusion of calorie and carbon emission information on menus, the influence on actual food choices has yielded mixed results. Some studies suggested a reduction in overall energy consumption with calorie labels (Littlewood *et al.*, 2016), but others find that such labels alone may not significantly influence food choices (Bleich *et al.*, 2017). Furthermore, the impact of such information on customers' perceptions of the restaurant's social responsibility and transparency image is still relatively unknown. Additionally, the presentation format of information on menus can have varying effects. For example, in a casual dining setting, diners tended to prefer visually appealing formats, such as images or labels, for nutritional information, while carbon intensity values were generally perceived positively but left many diners uncertain about their influence on food selection (Filimonau *et al.*, 2017a, 2017b). Diffusion of Innovation, delineates the intricate process through which novel concepts permeate through specific channels within a social system over time. It encompasses the diffusion resulting in the acceptance or penetration of new idea, behavior, or a tangible innovation. Introducing new ideas, even those with clear benefits, poses inherent challenges (Rogers, 2003). Given the novelty of including carbon emission and calorie information in Chinese restaurant menus in this region, where familiarity and awareness may be lower compared to other Western countries, this study aims to assess their impact on customers' food choices and their perception of the restaurant. Therefore, it is necessary to evaluate the effectiveness of different presentation formats, such as numeric versus reference values, for displaying calorie and carbon emission information on menus.

It is important to note that the majority of the previous studies were conducted within a Western fast food or casual dining context and mostly with Western samples. However, significant cultural differences exist between Chinese and Western consumers when it comes to dietary culture, encompassing distinct diet ideas, food objects, ways of eating, and table manners. Yang and Zhang (2010) stated that Chinese diners prioritize balance, harmony and moderation, embracing communal sharing and bite-size portions. In contrast, Western diners tend to prefer individual servings, larger portion sizes, and may exhibit a more indulgent attitude towards food, particularly for meat consumption. Consequently, it is crucial to investigate how Chinese consumers, with their unique cultural background, respond to calorie and carbon information presented on menus in Chinese restaurants. Hong Kong, renowned as a prominent culinary hub in Asia with over 17,000 restaurants (Arcibal, 2022), ranging from prestigious Michelin-starred establishments to vibrant street food stalls. It holds significant importance as a representative region for Chinese urban consumers. Additionally, Hong Kong's commitment to achieving carbon neutrality by 2050 (Carbon neutral@Hong Kong, 2023) and the implementation of the EatSmart@restaurant.hk Campaign (ESR Campaign, 2023) to promote healthier dining options align perfectly with the research objective. All these make Hong Kong an ideal and pertinent location for conducting this study. The present study aims to explore how calorie and carbon emission information presented in different formats on menus affect customers' food choices and perceptions of Chinese restaurants in an actual restaurant setting. The research objectives are as follows:

(1) to investigate how customers' food choice is associated with the presence or absence of calorie and carbon emission information on the menu;

(2) to explore how the presence or absence of calorie and carbon emission information on the menu affects customers' perceived social responsibility and transparency of the restaurant; and

(3) to examine the interaction effect between the information type and its presentation format on customers' perceived social responsibility and transparency of the restaurant.

2. Literature Review

2.1 Restaurant menu information as signals

Signaling theory, an economic and sociological theory, describes how people use signals to communicate information about themselves to others (Spence, 1978). Initially developed to explain the use of education credentials by employers as a signal of an employee's unobservable productivity, signaling theory has found application in various fields to elucidate how signals are employed to reduce uncertainty and convey information. This theory has been extensively employed in management studies, including marketing, entrepreneurship, and human resources management (Boateng, 2019; Celani & Singh, 2011; Ehrhart & Ziegert, 2005).

In restaurants, menus serve as signals regarding the restaurants' quality and the food and beverages offered. Through menu cues, restaurants can subtly influence customer behavior without limiting their freedom of choice (Reisch *et al*., 2021; Sunstein, 2014). For instance, price endings on menus can serve as extrinsic cues that signal a commitment to high-quality and high value, influencing decision-making processes (Naipaul & Parsa, 2001). Lo *et al*. (2017) suggested that restaurant menu labels are cues that help customers understand the products they will order and consume, with customers considering multiple menu attributes and prioritizing nutritional aspects over sustainability. Yu *et al*. (2020) found that handwritten menus may increase perceived authenticity and purchase intention in ethnic restaurants. Signaling theory serves as a foundation for this study, explaining how a menu can act as a signal or cue to convey information to customers. While menus serve as signals to customers, it is crucial for restaurants to provide accurate and clear information on their menus, as customers rely on this information for decision-making and it also impacts their perceptions of the restaurant.

2.2 The impact of calorie and carbon emission information on customers' choice

Increasingly, restaurants are displaying calorie and carbon emission information on menus, catering to health-conscious and environmentally-aware consumers. This trend has sparked a surge in research investigating consumer responses to health and environmental issues (Agrawal & Mittal, 2019; Chen *et al.*, 2023; Han *et al*., 2019; Li *et al*., 2021; Long *et al*., 2015; Shafieizadeh & Tao, 2020). Studies examining the impact of displaying energy or calorie content on menus have indicated that menu labels aid consumers in making informed decisions when dining out. A meta-analysis of menu labeling literature found that the overall energy consumption and ordering of energy-intense food decreased when menus included energy or calorie information (Littlewood *et al.*, 2016). Williams and Poulter (1991) found that consumers cared more about energy content but were confused by the food nutrition labels. Yoon and George (2012) indicated that the nutritional and calorie information on menus can influence consumer decision-making, particularly in casual dining restaurants. However, there is no consensus on whether providing nutritional information significantly affects consumers' dietary decisions. While consumers may be persuaded to make healthier choices based on information such as calories and fat content, nutritional information alone may not have a substantial impact on their food choices (Bleich *et al*., 2017; Castellari *et al*., 2018; Seenivasan & Thomas, 2016). In fast-food restaurants, easy-to-understand nutritional information encourages healthier meal choices, but in family restaurants, it has no effect (Lee & Lee, 2018;

Niven *et al*., 2019). Thus, the impact of nutritional or calorie information on menus varies based on the restaurant category and individual consumer nutrition beliefs.

In the realm of sustainable consumption, carbon emission information has gained prominence as a factor influencing customer choices, with a preference for products with lower carbon emissions (Vanclay *et al.*, 2011). With the growing diversity of food ingredients, cooking methods, and diners' demand, the restaurant industry faces an anticipated rise in carbon emissions. Addressing this issue necessitates interventions and strategies that encourage responsible and sustainable pro-environmental behavior among diners (Fauzi *et al.*, 2023). However, limited research exists on carbon labeling in restaurant menus due to the absence of mandates and the complexities involved in calculating carbon footprints for menu items. Lo *et al*. (2017) revealed that most customers of hotel restaurants prioritize nutritional information, with environmental impact information being of lesser importance. Previous studies investigating the impact of nutritional and environmental information have yielded inconsistent findings, prompting this study to examine the relationship between menu information and diners' choices in a real-world restaurant scenario. Factors like price, information format, and market share also play crucial roles in shaping consumers' decisions alongside carbon labeling (Gadema & Oglethorpe, 2011; Hartikainen *et al.*, 2014; Sharp & Wheeler, 2013). While environmental concerns are high, studies like Soregaroli *et al.* (2021) revealed that carbon footprint data alone may not significantly influence choices, emphasizing the need to explore nuanced interactions between information types and decision-making processes. This study aims to bridge existing gaps by exploring how the presentation of menus with and without calorie and carbon emission information influences customers' selection of items with lower environmental impact and calorie content.

H1a: The presence of calorie information has a significant positive relationship with customers' choice of low-impact menu items compared to its absence.
H1b: The presence of carbon emission information has a significant positive relationship with customers' choice of low-impact menu items compared to its absence.

2.3 Framing theory and Information processing theory

To investigate the impact of presentation formats on calorie and carbon emission information, framing theory and information processing theory, commonly utilized in communication studies (Carragee & Roefs, 2004; Harris *et al*., 2017), are employed. Framing theory (Goffman, 1974) explores how the presentation or framing of information influences individuals' perceptions, attitudes and decision-making. A frame is the "schemata of interpretation," which empowers individuals to pinpoint, perceive, identify, and label events and situations within their social world. This process allows them to attribute meaning to these occurrences, facilitating potential actions (Goffman, 1974). The way information is presented can shape how people interpret and understand it, ultimately influencing their responses and behaviors (Druckman, 2001).

Information processing theory suggests that individuals engage in either heuristic or systematic processing when encountering new information (Chaiken, 1980; Petty & Cacioppo, 2012). According to the theory, heuristic processing involves utilizing shortcuts, clues, proxies, or stereotypes to evaluate a situation, offering advantages such as increased efficiency and reduced cognitive effort compared to deeper processing. Conversely, systematic processing entails a more thorough and cognitive examination of information. The decision of whether individuals process new information heuristically or systematically is contingent upon their cognitive capacities and prior knowledge (Taylor & Fiske, 1978).

2.4 Information presentation format on restaurant menus

As menus are crucial in helping restaurant customers make informed choices and form perceptions about the image of the restaurant, it is important to ensure the information is being communicated effectively by using the most appropriate presentation format such as texts, numbers, symbols, and photos. Per the framing theory, the way information is presented can shape how people interpret and understand it, ultimately influencing their responses and behaviors (Goffman, 1974). For example, Kim *et al*. (2021) discovered that when a restaurant's menu effectively communicates a clean safety message, customers display a stronger revisit intention. Shafieizadeh *et al*. (2023) revealed that the attributes of restaurant messages significantly impact customers' perceptions of information credibility, adoption, and quality.

Restaurants can "nudge" customers to make low-impact choices by including calorie and carbon emission information on their menus. However, not all consumers grasp such information, and its presentation can affect its effectiveness. Proper presentation and explanation are required to ensure the message is understood. Previous studies have explored the effects of various presentation formats of nutritional and caloric information, such as numeric format, color-coded scheme, traffic light, tick symbol, and benchmark value. Morley *et al*. (2013) found that respondents who viewed menus without calorie information tended to select fast-food items with higher energy content compared to those who viewed menus displaying kilojoule or kilojoule plus traffic light information. Respondents also reported that the traffic light labels are useful when they were making decisions. In an experiment conducted by Pang and Hammond (2013), university students were presented with four types of menus: menus without calorie information, menus with absolute calorie counts only, menus with calorie counts and a suggested daily calorie intake statement, and menus with calorie counts and a physical activity scale (PAS) equivalent in terms of calories burned. The findings indicated that participants perceived the menu format with calorie information plus a health statement as the most understandable, while the menu format with calorie information plus a PAS was perceived as the most effective in promoting healthy eating. This aligns with a study by Bleich *et al.* (2012) on consumers' purchase behavior of sugar-sweetened beverages, which found that easily understandable caloric information, particularly when presented in a physical activity equivalent, could potentially reduce calorie intake. Another study by Dowray *et al*. (2013) found that respondents ordered the lowest calorie meals when shown the menu with calories and the number of miles to walk to burn the calories, followed by those shown with calories and the number of minutes to walk to burn those calories. The results suggested that the “miles to walk” label may be the most effective in influencing the selection of lower-calorie meals. Similarly, Wolfson *et al*. (2017) found that university students pay attention to the nutritional labels on grocery items and prefer both numeric and activity-equivalent calorie information. Consistently, these studies demonstrate that consumers prefer and find value in calorie information presented in a reference format that relates to the equivalent calories burned through specific physical activities.

When it comes to carbon emission information, consumers find it harder to understand than calorie information. In a study conducted by Upham *et al.* (2011), it was discovered that consumers, when confronted with numerical carbon footprint values, recognized that a higher number is undesirable. However, they struggled to ascertain whether the given value was acceptable. The study also emphasized that conveying carbon emissions through numerical figures can be challenging for most individuals to grasp. In contrast, information presented in a reference format that relates to everyday life is more accessible to the general public. Furthermore, they found that consumers found it easier to comprehend carbon emission

information when it was conveyed using traffic light colors. Osman and Thornton (2019) further suggested that labels including numeric carbon emissions would be more influential than just describing the environmental impact to consumers. Moreover, an eye-tracking study by Babakhani *et al*. (2020) examined whether consumers noticed carbon labels and local farmer labels with numeric and color-coded symbols benefits on restaurant menus. The findings indicated that both types of labels attracted little attention, suggesting that they may contribute to consumers' understanding of the environmental and local community impact but were insufficient in directing customers' food choices. Despite the prevailing notion that carbon emission information does not impact customers' ordering choices, there exists a research gap concerning its influence on customer perceptions of social responsibility and transparency of restaurants.

This study investigates the impact of two commonly adopted menu presentation formats, numeric and reference values, on communicating calorie and carbon emission information on restaurant menus. Framing theory guides this exploration, with numeric format emphasizing precision and objectivity, demanding analytical thinking and prior knowledge for a thorough understanding of the exact measurements or quantitative comparisons, while the reference format contextualizes information, making it relatable and accessible. Information processing theory further distinguishes the cognitive demands involved. Numeric data, requiring analytical processing, is more likely to be systematically processed by individuals. On the other hand, reference information leverages existing knowledge, facilitating effortless understanding, and is more likely to be processed heuristically. Crucially, this research distinguishes itself from previous laboratory-based studies by investigating in an actual restaurant setting, thereby capturing authentic customer decision-making and evaluations. By examining the interaction between presentation formats (numeric versus reference) and information types (calorie versus carbon emission), the study provides valuable insights into the intricacies of diners' choices and perceptions.

2.5 The impact of calorie and carbon emission information on consumers' perception of the restaurant and the brand

In addition to being "signals" communicating the characteristics and attributes of the food and beverage offerings in a restaurant menu, calorie and carbon information are also cues that may affect consumers' perceptions of the restaurant and the brand. Strategies conducive to building customers' trust, satisfaction, and loyalty are closely tied to how customers perceive the company's image in terms of its commitment in social responsibility and transparency.

Social responsibility - Environmental conservation, charitable giving, and the protection of labor rights are the primary manifestations of restaurant CSR (Kaur *et al*., 2022). Maloni and Brown (2006) suggest that promoting consumer food safety and health is also a socially responsible practice. Providing customers with information about their environmental and community impact is a demonstration of social responsibility. These responsible behaviors increase consumers' goodwill and their love for restaurant brands, and ultimately lead to customer retention (Lee *et al*., 2020). Companies that do not engage in social responsibility activities face consumer criticism and opposition, particularly in the food industry (Kim & Kim, 2014). Youn *et al*. (2016) discovered that long-term ethical behavior can improve the restaurant culture and the formation of moral ideals. Fulfilling social responsibility does not only imply financial benefits (Park & Lee, 2009), but it can indirectly influence consumers' evaluations of brands, products, and services through mediators like brand quality and preference (Bridges *et al*., 2019; Charlton & Cornwell, 2019). Kim and Stepchenkova (2020) revealed a positive

relationship between perceived CSR and brand satisfaction mediated by perceived brand quality in the context of restaurant consumers. Youn *et al*. (2015) also confirmed that consumer consumption behavior improves as restaurants improve their ethical performance.

H2a. Customers' perceived social responsibility of the restaurant is significantly higher when the calorie information on the menu is present than when it is absent.
H2b. Customers' perceived social responsibility of the restaurant is significantly higher when the carbon emission information on the menu is present than when it is absent.

CSR emphasizes socially responsible activities, social responsiveness, and contributive efforts that benefit society as a whole (Han *et al.*, 2020). In the hospitality and tourism industry, stakeholders are obligated to minimize harmful impacts and maximize beneficial impacts on society (Lee *et al.*, 2020). Environmental conservation and sustainability are key aspects of restaurant CSR (Kaur *et al.*, 2022). Therefore, CSR primarily focuses on societal impact, with environmental information, such as sustainable and local sources of food and carbon emission, having a larger-scale influence on behaviors and practices that contribute to the overall well-being of the planet. Conversely, calorie information is more closely linked to individual health significance. Therefore, when evaluating a restaurant's social responsibility, customers tend to prioritize the establishment's demonstration of commitment to ethical and sustainable practices (Kim & Ham, 2016), emphasizing whether the restaurant takes affirmative action in fulfilling its social responsibility obligations rather than the specific details of their impact. Consequently, the presence of carbon emission information on menus is more likely to generate a higher social responsibility perception from customers as compared to the presence of calorie information. The presentation format does not have any effect on the customers' perceived social responsibility.

H3. Customers' perceived social responsibility of the restaurant is significantly higher when carbon emission information is presented on the menu than when calorie information is presented, regardless of the presentation format.

Transparency - Rawlins (2008) defines transparency as a deliberate effort to provide accurate, timely, balanced, and unequivocal information, both positive and negative, with the aim of enhancing the public's reasoning ability and holding organizations accountable for their actions, policies, and practices. Similarly, Kundeliene and Leitoniene (2015) define transparency as the act of publicly and clearly providing information. Its essence lies in promoting openness and clarity, rather than fostering confidence and ambiguity (Norman *et al.*, 2010). Transparency in restaurants involves open disclosure of information about ingredients, sourcing, food preparation, and environmental impacts. Restaurant transparency boosts consumer trust, service quality, willingness to choose, CSR perception, and positive evaluation (Shafieizadeh & Tao, 2020). The provision of information about food ingredients and nutrition labeling creates a perception of transparency among customers (Freeman, 2015). Kang and Hustvedt (2014) found that when restaurants are transparent about their activities, they experience less suspicion and higher consumer trust. Shafieizadeh and Tao (2020) discovered that local food information on a restaurant's menu positively influences customers' perceptions of transparency and CSR, increasing trust and ultimately affecting their willingness to patronize. The facilitation of transparency through the provision of high-quality nutritional and environmental information can serve as a distinguishing factor for competitors in the market. Transparency in the food supply chain improves the perception of food authenticity and enhances consumers' positive evaluation as authentic (Yang *et al*., 2022). Price transparency

reflects the service quality of restaurants (Agrawal & Mittal, 2019). Nguyen *et al*. (2022) indicated that consumers are willing to pay more for information transparency.

H4a. Customers' perceived transparency of the restaurant is significantly higher when the calorie information on the menu is present than when it is absent.
H4b. Customers' perceived transparency of the restaurant is significantly higher when the carbon emission information on the menu is present than when it is absent.

Transparency underscores the importance of openly communicating and disclosing comprehensive and accurate information. A crucial element of transparency emphasizes the significance of ensuring information is easily comprehensible, thorough, and readily available. If information is not effectively communicated or easily accessible, its influence on perceived transparency may be constrained, even when physically present.

Generally, understanding carbon emission information proves to be more challenging compared to calorie information (Upham *et al.*, 2011). Calorie values are commonly found on food labels in grocery stores and are linked to weight management, making the concept widely familiar to the general public. On the flip side, carbon emission information involves quantifying greenhouse gas emissions and understanding the carbon footprint, which can be unfamiliar and more complex for many individuals (Röös & Tjärnemo, 2011). Therefore, the use of reference format should significantly enhance the perceived transparency for carbon emission information, aiding comprehension for those who may find it challenging. In contrast, regardless of whether calorie information is presented in numeric or reference format, which is widely recognized by the public, it is not expected to yield a significant difference in customers' perceived transparency.

H5a. Customers' perceived transparency of the restaurant shows no significant difference when the calorie information is presented in reference format and numeric format.
H5b. Customers' perceived transparency of the restaurant is significantly higher when the carbon emission information is presented in reference format than in numeric format.

3. Methodology

3.1 Research design

The present study employed a field experiment in an actual Chinese restaurant setting during meal periods involving consumers dining in the restaurant. This approach aims to provide more practical implications for restaurant operators. In contrast to prior research, the present study delved into consumers' actual choices in a real-world restaurant setting, rather than merely exploring their intentions. To eliminate the influence of "price" on customers' decision-making process, this study utilized a Chinese Set Lunch menu where the per-person price remained consistent. Customers were presented with a selection of soup (choose 1 out of 2) and a main course (choose 1 out of 3) without the influence of price differentiation, while other menu items including Chinese dim sum, appetizers, and dessert were fixed.

The experimental group, where menus displayed calorie/carbon emission information, was compared with the control group, which featured menus without such information. This comparison aimed to determine whether the presence of such information would influence consumers' dietary choice and their perception of the restaurant. To investigate the impact of carbon emission and calorie information presented in either numeric format or reference value on perceived social responsibility and transparency, a 2×2 between-subject experimental

design was employed. This factorial design enabled researchers to examine the interaction and main effects of the information type and presentation format (Hegner *et al*., 2021).

3.2 Stimuli

A Life Cycle Assessment (LCA) was undertaken to quantify the carbon emissions (measured in kilograms of CO2) associated with each menu item served at the restaurant. This assessment encompassed both direct (i.e., kitchen operations) and indirect (i.e., supply chain sourcing) contributions to emissions. Data were obtained from the hotel, including food procurement records, food storage, preparation, and cooking methods, wastage, and utility consumption. To gain further insights, interviews were conducted with key personnel, including the executive chef, Chinese restaurant chef, food and beverage director, and restaurant manager. Observations were carried out in the kitchen and restaurant dining areas to understand the various processes involved in the daily operation of the establishment. The carbon emissions for each food item on the set lunch menu were calculated based on their specific life cycle inventories, which considered the food ingredients used and their respective supply chains, as well as the energy and resource requirements as per the restaurant's recipe information. The caloric information for the menu items was estimated based on the ingredients and the cooking methods used. Carbon emissions were presented either numerically, in kilograms of CO2, or using a reference value system of H, M, and L to represent high, medium, and low emissions. Similarly, calorie information was presented in the numeric format of kilocalories or a reference value indicating the calories burned through brisk walking at a speed of 8kph for a specific duration. Additionally, a control group menu version was designed without any calorie or carbon information, resulting in a total of five menu versions. Please refer to Appendices A and B for the menus.

3.3 Measurements

A questionnaire was designed to gatherinformation on the diner's soup and main course along with their perceptions of the restaurant's social responsibility (adapted from Shafieizadeh & Tao, 2020) and transparency (adapted from Yang *et al*., 2022). All items were measured on seven-point Likert scales anchored by strongly agree (7) to strongly disagree (1). As suggested by Taherdoost (2019), the seven-point item scale is recommended as the most accurate and easiest to use for reflecting respondents' true subjective evaluations, considering factors such as inter-rater reliability, validity, and discriminating power. Demographic and dining-out behavior information were also collected. The questionnaire originally drafted in English was professionally translated into Chinese by following the "back-translation" procedure (Brislin, 1986). To ensure the clarity of the questionnaire and to validate the recognition of the different menu stimuli, a pre-test involving three academicians and five diners was conducted. Minor adjustments were made based on their feedback to enhance the questionnaire's clarity. A pilot test with 30 diners at the restaurant validated the data collection procedure.

To reduce the possibility of common method bias, some procedural measures were incorporated based on the suggestion of Podsakoff *et al*. (2012). These measures included shuffling of the questions measuring the dependent variables in the online survey, maintaining a proximal separation of measurement items, and ensuring respondent anonymity. Additionally, the utilization of an experimental design also diminished common method bias concerns (Butcher & Chomvilailuk, 2022). Furthermore, the Heterotrait-Monotrait (HTMT) ratio was employed as a recommended statistical control for common method bias (Hair *et al*. 2019).

3.4 Procedure and sample

Ethical approval for the research was obtained from the university's Institutional Review Board (Ref. 20220809002). This study was conducted in a Chinese restaurant situated within

a hotel in Hong Kong. Data was collected over a four-week period from October to November 2022. Hong Kong locals have a prominent dining-out culture, as locals frequently eat out, supported by the city's impressive ratio of one restaurant for every 470 people (Invest HK, 2023). As a result, they form a significant portion of restaurant clientele, especially in hotel establishments. This is evidenced by the fact that hotels in Hong Kong put much of their marketing resources into appealing to the local market (Institute of Hospitality, 2021).

Respondents were individuals aged 18 or above who dined during lunchtime. Diners were presented with the set-lunch menu showing either calorie, carbon emission levels, or showing neither of this information. After placing their food orders, participants were invited to participate in a survey, either on paper or online via a QR code. As an incentive, those who completed the survey received a dining voucher worth HK$50 (around US$6.5). A total of 181 usable responses were collected, surpassing the recommended minimum of 30 cases for each tested scenario (Wu *et al*., 2015). Table 1 shows the descriptions of the interventions (information type and presentation format) and the corresponding number of valid responses collected from each experiment.

[TABLE 1 HERE]

3.5 Data analysis

Chi-square tests were used to examine the relationship between the presence of calorie/carbon information and low-impact dining choice behaviors. Moreover, the impact of calorie/carbon information on customers' perceived social responsibility and transparency of the restaurant was assessed using independent samples t-tests. Two-way ANCOVA was employed to analyze the effects of the two independent variables (information type and presentation format) on the two dependent variables (social responsibility and transparency), while accounting for covariates such as age and gender based on prior research (Attwood *et al.*, 2020; Neff *et al.*, 2018).

4. Findings

4.1 Respondents' characteristics

Table 2 shows that 53.7% of the respondents were female, with the majority falling in the ages of 40-49 (24%) and 50-59 (27.4%). Furthermore, more than 80% of the respondents had a college degree or above, while over 50% of them were repeat customers of the restaurant. Nearly 40% of the respondents dined outside their homes 1 to 3 times per week, and 33% dined out 4 to 6 times.

[TABLE 2 HERE]

4.2 Relationship between menu information and the choice of low-impact menu items

Four Chi-square tests were conducted to assess if there was any association between the type of information presented on the menu and the respondents' choice of soup and main courses with lower impact. [1) With calorie information and no calorie information (control) and 2) With carbon emission information and no carbon emission information (control)]. All expected cell frequencies were greater than five. As none of the Chi-square statistics was significant ($p = 0.849$ for calories of soup, $p = 0.975$ for calories of main course, $p = 0.986$ for

carbon emission of soup, p = 0.423 for carbon emission of main course), the results indicated that there is no correlation between the type of information presented on the menu and the selection of menu items with lower carbon emissions or fewer calories. Consequently, H1a and H1b were unsupported. There is no correlation between the presence of calorie and carbon information and diners' selection of low-impact menu items.

4.3 Reliability and validity

According to Table 3, the constructs and their dimensions demonstrated satisfactory internal consistency, as evidenced by Cronbach's alpha (α) and composite reliability (CR) values exceeding the minimum threshold of 0.7 (Hair *et al*., 2019). Furthermore, the convergent validity was supported by the fact that all average variance extracted (AVE) values exceeded 0.5 (Fornell & Larcker 1981). Moreover, the HTMT ratio between the two constructs was 0.509, which falls below the recommended threshold of 0.9 as suggested by Henseler *et al*. (2015), confirming discriminant validity.

[TABLE 3 HERE]

4.4 Influence of calorie and carbon information on customer perceptions

Four independent samples t-tests were run to examine the significance of differences between the experimental group (presence of calorie/carbon information) and the control group (no information) on perceived social responsibility and transparency of the restaurant. The findings indicated that there was no significant difference between the experimental group (with calorie information) and the control group (no information) concerning social responsibility (p = 0.102) and transparency (p = 0.195). However, a significant difference was observed between the experimental group (with carbon information) and the control group (no information) in terms of social responsibility (95% CI [0.093, 0.661], t (86.575) = 2.636, p = 0.010), while no significant difference was found in terms of transparency (p = 0.571). Specifically, the experimental group with carbon information exhibited a significantly higher mean score on social responsibility (M = 6.099) compared to the control group (M = 5.722). Thus, H2b was confirmed, while H2a, H4a and H4b were unsupported.

4.5 The interaction effects between information type and presentation format

To test H3, H5a, and H5b, a two-way ANCOVA was conducted to examine the interaction effects between information type and presentation format on customers' perceived social responsibility and transparency. Age and gender were included as covariates to control for their potential influence. Assumption tests were conducted, including outlier assessment, normality testing, homoscedasticity and homogeneity of variances testing. The results of the two-way ANCOVA with and without the outliers were compared and the result was not substantially affected. Homoscedasticity was observed through visual inspection of residuals, and Levene's test confirmed the homogeneity of variances (p = 0.165 for social responsibility, p = 0.519 for transparency). Despite there were deviations from normality in some cells based on Shapiro-Wilk's test, it is still viable to conduct the two-way ANCOVA since this method is fairly robust to deviations from normality (Bray & Maxwell, 1985; Weinfurt, 1995, as cited in Laerd Statistics, 2016).

The results indicated that there was no significant interaction effect between information type and communication format (p = 0.445) on social responsibility, while controlling for age and gender. As a result, separate main effects analyses were conducted. The results revealed a significant main effect of information type (F (1, 134) = 21.302, p < 0.001, partial η2 = 0.137), but not for presentation format (p = 0.250). Specifically, the adjusted marginal mean social

responsibility score in the carbon group (M = 6.093) was significantly higher than the calorie group (M = 5.521), irrespective of the presentation format. The findings were visually presented in Figure 1. Therefore, H3 was supported.

Results show a significant interaction effect between information type and presentation format (F (1, 134) = 10.406, p =0 .002, partial η2 = 0.072) on transparency. Further examination of the simple main effects for presentation format showed a significant difference between numeric format and reference format when carbon information was provided (F (1, 134) = 14.743, p < 0.001, partial η2 = 0.099). However, no significant difference was found when calorie information was provided (p = 0.541). Specifically, when carbon emission information was presented, the reference format yielded a significantly higher transparency score (M = 6.118) compared to the numeric format (M = 5.214). Figure 2 visually illustrated these results. Thus, H5a and H5b were confirmed.

[FIGURE 1 HERE]
[FIGURE 2 HERE]

The mean scores of the four different experimental groups and the control group were further analyzed. As shown in Table 4, there were significant differences in the perception of social responsibility between the groups. The group exposed to the menu with carbon emission information presented as a reference value (Group 2) had the highest perception mean score of 6.219, followed by the group shown numeric carbon emission information (Group 1) with a mean score of 5.979. The group shown numeric calorie information (Group 3) had the lowest mean score of 5.504. Group 1 exhibited a significantly higher perceived social responsibility than Groups 3 and 4. Group 2 displayed a significantly higher perceived social responsibility than Groups 3, 4, and 5.

In terms of transparency, the group shown carbon emission information presented as a reference value (Group 2) had the highest perception score of 6.094, while the group shown numeric calorie information (Group 3) had the lowest score of 5.333. Group 2 had a significantly higher perception score for transparency than Groups 1, 3, 4, and 5.

[TABLE 4 HERE]

In conclusion, the results of the hypotheses are summarized in Table 5.

[TABLE 5 HERE]

5. Discussion

This is one of the first studies conducted in an actual restaurant to examine the impact of calorie and carbon emission information and their presentation format on diners' food choices and perceptions in a Chinese restaurant setting. The findings suggested that the provision of carbon emissions or calorie content on the menu does not significantly influence diners' selection of lower-impact menu items. While some previous studies conducted online or in simulated casual dining settings (e.g., Morley *et al.*, 2013; Yoon & George, 2012) have shown that nutritional and calorie information on menus can influence consumer decision-making, it is important to note the disparities between behavioral intentions and actual behavior that people's actions may not always align with their stated preferences (Miller, 2003). Additionally,

people often indulge more when dining out (Anderson *et al*., 2023; Glanz *et al*., 2007; Josiam & Foster, 2008). Since this study took place in a Chinese restaurant within a hotel setting, diners may perceive such experiences as special occasions, potentially making them less concerned regarding calorie and carbon emission information.

The findings of this study align with previous research suggesting that providing calorie and carbon footprint information may not directly impact diners' food choices. Studies conducted by Babakhani *et al.* (2020) and Soregaroli *et al*. (2021) similarly demonstrated that presenting environmental information does not significantly affect consumers' selection of environmentally friendly options. Furthermore, Vanclay *et al*. (2011) indicated that calorie information might be discounted due to perceptions that healthier food options are less satisfying and tasty, leading to limited or inconsistent effects on food choices.

However, our study uncovered a noteworthy difference: while both types of information did not significantly affect food choices, diners being shown menus displaying carbon emission information have higher social responsibility scores for the restaurant, whereas those receiving menus with calorie information did not demonstrate such influence. This impact stems from the association of carbon emission data with environmental sustainability, appealing to consumers concerned about broader societal well-being. Carbon emission information signals a restaurant's commitment to a sustainable future, possibly aligning with the preferences of environmentally conscious consumers (Vanclay *et al*. 2011). In contrast, calorie information primarily pertains to personal dietary choices and individual health considerations, lacking the same societal resonance. Its impact on social responsibility is less pronounced as it may not be directly linked to broader societal concerns. Additionally, it is worth noting that the sensitivity of customers towards calorie information may be influenced by their attitudes towards health and can vary based on factors such as age, gender, and ethnicity (Lanoye *et al.*, 2016), further affecting the extent to which calorie information influences perceptions of social responsibility.

Nonetheless, customers' perceived transparency did not demonstrate any significant difference when different types of information (calorie and carbon emission) were shown on the menu. Other factors, such as price, food sourcing practices, ingredient information, and cooking methods, may also play a role in shaping transparency perceptions (Nguyen *et al*., 2022). Individuals may have different motivations for eating out and prioritize factors other than carbon and calorie content (Lo *et al*., 2020; Petersa & Remaud, 2020). Therefore, the provision of calorie and carbon emission information alone may not significantly impact customers' overall perception of transparency.

This study also evaluated the interaction effect of information type and presentation format on social responsibility and transparency. Although no interaction effect was observed on social responsibility, the information type demonstrated a significant main effect. Specifically, regardless of the presentation format, the mean score for perceived social responsibility was significantly higher for customers presented with menus with carbon emission information compared to those with calorie information. It is consistent with the previous discussion, highlighting the broader societal impact of environmental information. On the other hand, calorie information carries more individual relevance. When it comes to transparency, the study findings unveiled an interaction effect between information type and presentation format. Specifically, when carbon emission information was presented in a reference format on the menu, diners perceived significantly higher transparency compared to when it was presented numerically. However, such significant differences were not observed when presenting calorie information on the menu. This distinction can be attributed to the fact that carbon emission information is often more complex and challenging to comprehend by the general public compared to calorie information (Upham *et al.*, 2011). Transparency refers to

the extent to which individuals can readily access and clearly understand the necessary information for evaluation (Zhou *et al.*, 2018). If the information is not effectively communicated or easily accessible, it may not significantly impact perceived transparency. Conversely, when information is easily understood, the specific presentation format becomes less influential. Therefore, the reference format significantly enhanced perceived transparency for carbon emission information, which can be more challenging for most individuals to comprehend. In contrast, no significant difference was observed for calorie information, which may be relatively easier to grasp.

In addition, we compared the four groups (information type × presentation format) with the control group (no information) on perceived social responsibility and transparency. Overall, while not all distinctions of calorie and carbon information between the reference format and the numerical format were statistically significant, there is a notable observation in the mean scores: the reference format yields higher values compared to the numerical format. Upon closer examination, diners who were shown a menu with carbon emission information presented as a reference value had the highest perception scores for social responsibility and transparency. Intriguingly, the transparency score was highest in the group exposed to carbon emission information presented in reference values, while the group with carbon information presented in numeric format had the lowest score. This observation highlights the notable impact of presentation formats on transparency perception, particularly when information is complex. It suggests that consumers may struggle to comprehend the absolute effects of numeric carbon emission values and cannot determine whether a given value is high, low, acceptable, or unacceptable. However, in cases where calorie information is already familiar to the general public, such a disparity does not exist. In summary, these findings provide support for the effectiveness of incorporating carbon emission information on menus as a promising strategy to enhance perceived social responsibility. The significance of the presentation format on perceived transparency, however, appears to be relevant primarily when the information is challenging to comprehend.

6. Implications

6.1 Theoretical implications

This study addresses a research gap by examining the influence of menu information and presentation format in a hotel Chinese restaurant dining context. By utilizing actual consumption data and surveying diners, it offers valuable insights that surpass previous studies relying solely on reported intentions or online experiments. The results further expand the application of signaling theory in comprehending the influence of carbon emission and calorie information on diners' choices and perceptions of the restaurant.

The study found that offering carbon and calorie information on the menu does not influence diners' choice of lower-impact menu items, however, the presence of carbon emission information can impact diners' perceived social responsibility to the restaurant. It holds theoretical significance in advancing the concept of social responsibility. It highlights that for hotels and restaurants to truly embrace social responsibility, the value they provide must extend beyond customers' personal interests and contribute to the well-being of society as a whole. Merely offering benefits that serve individual interests is insufficient to enhance customers' perceived social responsibility of the hotel or restaurant. The findings indicated that providing such information had no impact on the perception of transparency. It makes a valuable contribution to the concept of perceived transparency. It emphasizes that a customer's perception of transparency is influenced by multiple sources of information, rather than being

solely reliant on a single piece of information. In addition to openness, transparency should also encompass the essential criteria of information being clear, accurate, accessible, and unequivocal, reiterating its crucial function in facilitating the retrieval of valid information for evaluation purposes.

Furthermore, this study contributes to the enhancement and expansion of the framing theory and the information processing theory within the context of menu design. By employing signaling theory as a guiding framework for conveying information and company value, the study demonstrates how the framing theory and information processing theory can effectively guide the communication of information. It emphasizes the significant role of presentation format, particularly when the information is difficult to comprehend. Precisely, it highlights the importance of employing heuristic processing when information is challenging to comprehend. However, when the information recipient possesses sufficient cognitive abilities and prior knowledge, there is no significant difference in the outcome of heuristic and systematic processing. This is demonstrated by the fact that calorie information has comparatively higher familiarity than carbon emission information.

6.2 Practical implications

This study investigates how hotel Chinese restaurants can mitigate their impact by adopting a redesigned menu featuring factual information regarding environmental and health implications to guide influence diners' food choices. The findings underscore several significant managerial implications. While this study suggests that the presence of calorie or carbon emission information may not significantly influence diners' selection of low-impact items on the menu, providing such information can still serve as a source of inspiration for restaurants to explore alternative initiatives that promote sustainability and a healthy lifestyle. Restaurant managers should persist in their commitment to responsible business practices as perceived ESG practices positively affect employees, enhancing their organization-based self-esteem, organizational commitment, and ultimately contributing to employee retention (Kim et al., 2024).

Given that the restaurant serves as a primary touchpoint for hotel customers, a successful "green" initiative hinges on the active involvement and commitment of various stakeholders, including employees, suppliers, customers, environmental specialists, and regulatory bodies (Chua & Han, 2022). The research highlights that presenting that carbon emission information, irrespective of the communication format employed, enhances customers' perception of social responsibility. By featuring carbon emission details on their menus, restaurants may attract customers who prioritize environmental sustainability. Consequently, it is imperative for restaurants to incorporate such information into their menu. To achieve this, restaurant managers should collaborate with experts to assess the carbon emission of menu items, subsequently integrate this information into menus, empowering patrons in their decision-making process.

For restaurant chains and hotel groups, establishing a comprehensive localized database detailing ingredients and cooking techniques facilitate the LCA of menus. LCA enables restaurants to understand their emission levels as a cohesive entity. One readily implementable strategy for restaurants is prioritizing locally sourced, indigenous, fresh, and nutritious ingredients. This approach not only reduce the carbon footprint of the dishes but also enhances the authenticity of the restaurant (Badu-Baiden et al., 2022). Additionally, careful consideration should be given to the use of clean and environmentally friendly energy sources and modifying cooking methods to minimize energy consumption Furthermore, forging partnerships with environmental consultants facilitates the development of carbon accounting protocols at both

organizational and outlet-specific levels. This endeavor entails monitoring and disclosing carbon emissions throughout the restaurant chain, offering improved insights into key areas impacting the carbon footprint.

The study reveals that presenting carbon emission information in reference value format proves more effective in shaping consumers' perception of the restaurant's transparency compared to numerical formats. Consequently, it is important for restaurants to display carbon emission information on their menus in a clear and concise manner that is easily comprehensible for customers. In this regard, presenting carbon emission information in reference value format can enhance consumers' transparency perception of the restaurant. Furthermore, restaurants and hotels can elevate customer awareness and comprehension by offering more than just basic carbon emission "values" on menus. They can provide easy-to-understand information elucidating the environmental impact of their food choice on their websites and social media, possibly through a QR code on the menu. Han et al. (2021) asserted that social media plays a crucial role in providing vital information to tourists. They also highlighted the significant influence of the framing and communication of user-generated content on environmental issues on people's understanding, personal norms, and intentions (Han et al., 2018). When communicating carbon footprint information, it is essential to make it relevant easy to understand, and engaging for the customers. Utilizing video content or reels can be particularly effective in capturing customers. Hence, employing popular science videos to illustrate the adverse effects of environmental damage caused by excessive carbon emissions can be instrumental. Restaurants must educate consumers about the environmental repercussions of carbon emissions and inspire them to contribute to the United Nation's 2050 carbon neutrality goal. By involving customers to participate in the company's CSR activities, such as interactive games and educational videos, restaurants can enhance brand-consumer relationships by highlighting the psychological and functional benefits associated with participation (Lo, 2020).

Several restaurant chains and institutional establishments in the US and UK (Collings, 2021; Gallagher, 2022) have already begun voluntarily incorporating carbon footprint information on their menus, underscoring the belief that responsible businesses must take decisive action. In the present landscape, airlines are introducing carbon offsetting options for passengers to mitigate the environmental impact of air travel (Jockims, 2022). This concept holds promise for adaptation within the restaurant sector. As consumers increasingly prioritize awareness of carbon emissions and their ecological footprint, restaurants may introduce carbon emission charge of offset fees to the restaurant bill. Customers can be offered the choice to opt out of the "carbon emissions charge" associated with their meal selections (Doshi, 2023). By incorporating a carbon emission charge or emission offset fees into bills, restaurants can channel proceeds towards initiatives such as reforestation, renewable energy, or carbon capture. This not only fosters social responsibility but also enables customers to actively participate in reducing the carbon footprint of their dining experience, thereby advancing sustainability within the industry. Additionally, policymakers could consider providing funding to restaurant operators to work with professionals in conducting LCAs and incentivizing restaurants to disclose emission data on menus, fostering transparency and promoting environmentally conscious dining habits as part of corporate social responsibility efforts. It's crucial to acknowledge that resource availability varies among different types of restaurants (e.g., independent stand-alone, restaurant chains, restaurants operated and managed by hotels, etc.). Therefore, recommendations need to be tailored based on the specific operational characteristics of different types of restaurants.

7. Limitations and future studies

The study has limitations that need to be acknowledged. The small sample size, while focusing on local residents, might not fully represent all Chinese restaurant diners, affecting the generalizability of the findings. Future research could include larger and more diverse samples of different cultural background to ensure a broader representation of the population. Moderating role of culture in influencing consumer behavior, beliefs and attitudes can be investigated in the future (Chwialkowska, 2021). Additionally, future studies could explore diverse presentation methods beyond alphabetical codes, such as color-coded logos or textual descriptions, offering a nuanced understanding of sustainability information impact. Combining numeric and reference value data could also yield richer insights. Since family-style dining is common in Chinese restaurants, where dishes are shared among diners, it would be valuable to investigate how calorie and carbon emission information influences decision-making dynamics within individual versus group settings. Furthermore, considering the significant individual variations in beliefs and attitudes toward health and the environment, future research should explore these factors to gain a more comprehensive understanding of their influence on dining choices. Lastly, given the study's foundation in signaling theory, framing theory, and information processing theory, future research can delve into how different cues and signals affect diners' information processing methods, contributing to a better understanding of persuasive strategies in dining choices. Addressing these avenues of research would provide valuable insights into the complex decision-making processes of diners in restaurant settings.

Acknowledgment

This project is funded by The Hong Kong Polytechnic University under Grant (G-UAPP); and City University of Hong Kong under Grant (CityU 11219622).

Declaration of interest

We have no conflicts of interest to disclose.

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Table 1. Usable sample size and the description of the intervention for each experiment

Presentation format	Carbon emission information	Usable sample size	Calorie information	Usable sample size	Control	Usable sample size
Numeric	X Kg of CO_2	32	X KCal	45	No carbon or calorie information	36
Reference value	H / M / L	32	X minutes of brisk walking (equivalent to the calories burned by the number of minutes of brisk walking @8kph)	36		

Table 2. Respondents' profile (n=181)

	Count	%		Count	%
Gender			**Age**		
Male	81	46.3	18-29	15	8.4
Female	94	53.7	30-39	28	15.6
Total	175	100.0	40-49	43	24.0
			50-59	49	27.4
Education level			60-64	25	14.0
Secondary/middle school	27	15.1	≥65	19	10.6
College/undergraduate	90	50.3	Total	179	100.0
Postgraduate	62	34.6			
Total	179	100			
First visit to this restaurant			**No. of times dining outside home in the past week**		
Yes	78	43.1	1 to 3	71	39.7
No	103	56.9	4 to 6	59	32.9
	181	100.0	7 to 9	20	11.1
			10 to 12	15	8.4
			13 or more	14	7.9
				179	100.0

Table 3. Results of reliability tests and mean scores of respondents' perception of the restaurant

Respondents' perception	Mean	Factor loading	Cronbach's Alpha	CR	AVE
Social responsibility			0.869	0.872	0.696
This restaurant is socially responsible	5.99	0.827			
This restaurant is concerned about improving the well-being of the society	5.85	0.920			
This restaurant shows its commitment to society and the environment	5.45	0.748			
Transparency			0.877	0.879	0.708
This restaurant allows me to understand their efforts in sustainability	5.39	0.854			
This restaurant allows me to understand the impact of our consumption on the environment and ourselves	5.39	0.858			

Respondents' perception	Mean	Factor loading	Cronbach's Alpha	CR	AVE
The restaurant acknowledges the customers' right to know the information about the ingredients used	5.64	0.812			

Table 4. Effect of Menu Information on Perceptions of Restaurant Social Responsibility and Transparency

Group	1	2	3	4	5				
	Carbon	Carbon	Calorie	Calorie	None				
	Numeric	Reference	Numeric	Reference	Control	Total	F	Sig.	Difference
Social Responsibility	5.979	6.219	5.504	5.528	5.722	5.762	6.998	0.000	1>3,4 2>3,4,5
Transparency	5.219	6.094	5.333	5.259	5.546	5.475	5.064	0.001	2>1,3,4,5

Significant at P≤0.05

Table 5. Summary of Hypothesis Testing Results

H1a: The presence of calorie information has a significant positive relationship with customers' choice of low-impact menu items compared to its absence.	Unsupported
H1b: The presence of carbon emission information has a significant positive relationship with customers' choice of low-impact menu items compared to its absence.	Unsupported
H2a. Customers' perceived social responsibility of the restaurant is significantly higher when the calorie information on the menu is present than when it is absent.	Unsupported
H2b. Customers' perceived social responsibility of the restaurant is significantly higher when the carbon emission information on the menu is present than when it is absent.	Supported
H3. Customers' perceived social responsibility of the restaurant is significantly higher when carbon emission information is presented on the menu than when calorie information is presented, regardless of the presentation format.	Supported
H4a. Customers' perceived transparency of the restaurant is significantly higher when the calorie information on the menu is present than when it is absent.	Unsupported
H4b. Customers' perceived transparency of the restaurant is significantly higher when the carbon emission information on the menu is present than when it is absent.	Unsupported
H5a. Customers' perceived transparency of the restaurant shows no significant difference when the calorie information is presented in reference format and numeric format.	Supported
H5b. Customers' perceived transparency of the restaurant is significantly higher when the carbon emission information is presented in reference format than in numeric format.	Supported

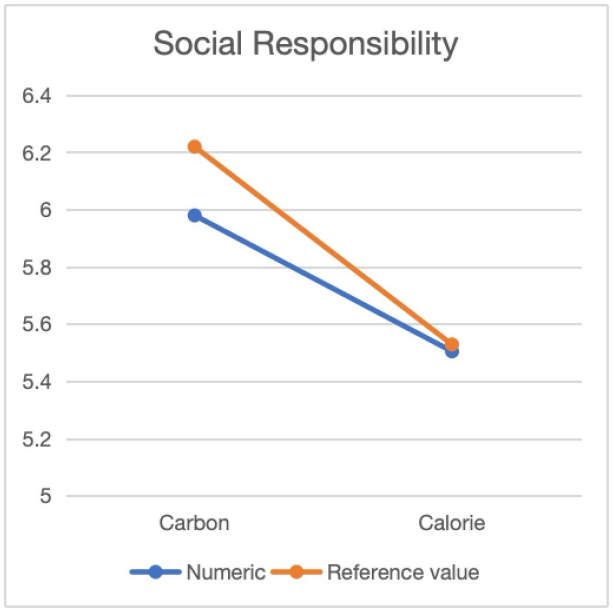

Figure 1. Interaction effect between information type and presentation format on social responsibility

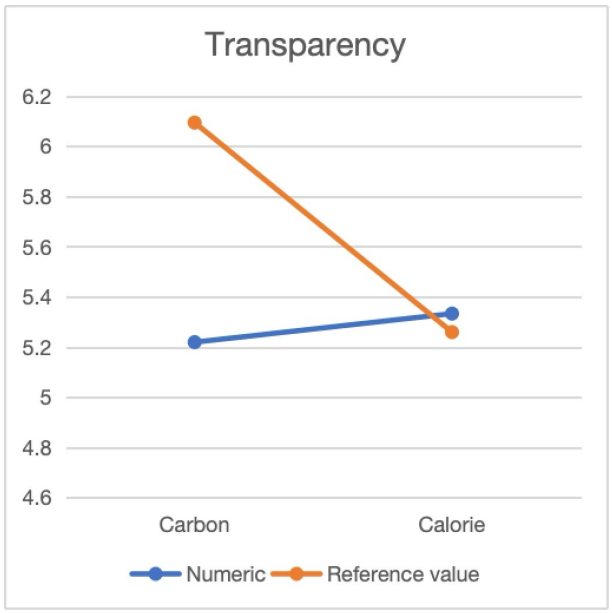

Figure 2. Interaction effect between information type and presentation format on transparency