Revolutionizing the Restaurant Industry: Exploring the Implementation and Impact of Blockchain Technology on the Dining Experience

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Abstract

This research conducted two studies to explore the application of blockchain technology (BCT) in the food supply chain, with a focus on restaurants. The first study used a service design workshop to examine how BCT influences customer dining experiences with different personas. The second study employed partial least squares-structural equation modeling (PLS-SEM) to validate hypotheses from the first study. Findings show that customer innovativeness and cryptocurrency ownership positively relate to transparency perceptions in the food supply chain. Enhanced transparency is associated with improved perceived food safety, quality, and naturalness, elevating customer satisfaction and electronic word-of-mouth (eWOM) behavior. Additionally, food safety concerns and health consciousness intensify the relationship between transparency and perceived food safety and quality. This research contributes to technological innovation literature, expands the information processing theory, and provides insights for restaurant owners, policymakers, and technology developers regarding BCT adoption in the restaurant industry.

Keywords: Blockchain, transparency, food perceptions, health, innovativeness, customer satisfaction, electronic word-of-mouth (eWOM).

1.Introduction

Food safety and quality have emerged as urgent global concerns, as evidenced by the alarming statistic that 1 in 10 individuals worldwide falls ill each year due to contaminated food, resulting in a staggering 33 million deaths (WHO, 2023). Particularly concerning is the vulnerability of children under 5, who experience 420,000 deaths annually (WHO, 2023). Urbanization, climate change, migration, and travel present additional complexities in efforts to ensure food safety and quality. These external factors have profound implications for sanitation, hygiene practices, weather patterns, water availability, and the introduction of new pests and diseases (Ringsberg, 2014; Zhong et al., 2017). Moreover, the prevalence of food scandals and frauds, such as the incidents involving Subway's chicken, olive oil fraud, Burger King's horse meat scandal, and the presence of fake eggs in the Chinese market, has significantly eroded consumer trust when they dine out in the restaurant industry (CBC, 2017; CBS, 2016; Guardian, 2013; Time, 2012). These cases have garnered substantial attention and underscored the urgent need to address the pervasive issues surrounding food safety and quality.

As a result, restaurants that offer safe and high-quality dishes tend to attract more customers, making transparency of food supply chain an essential component of their competitive advantage (Bosona & Gebresenbet, 2013). However, the current food supply chain relies on a centralized authority to manage information flow, which can be manipulated by companies to provide customers only with the information they want them to have (Davies et al., 2021). This makes it challenging for consumers to assess the trustworthy information of products without relying on an authoritative testing department or medical evidence (Zulfakar et al., 2014). Therefore, there is a growing demand for innovative technologies to improve the transparency of the food supply chain.

One technology that has been proposed as a potential solution to enhance transparency in the food supply chain is blockchain technology (BCT). BCT is a shared and immutable ledger that records transactions, tracks assets, and establishes trust (Duan et al., 2020). By leveraging BCT, customers can better understand the production process of the food they consume, thereby increasing their confidence in its safety and quality (Rana et al., 2021). This can facilitate the tracking of food products throughout the supply chain, expedite the identification of specific products from specific suppliers, and streamline quality inspections (Duan et al., 2020). Despite the potential benefits of BCT, its use in the restaurant industry is still in its early stages, and only a few studies have explored its potential applications and customer perceptions. Therefore, this research evaluates the potential of BCT in enhancing transparency in the restaurant industry and provides insights into the factors that influence customer perceptions of BCT-based solutions.

This research paper attempts to explore (1) how BCT transparency affects customer food perceptions, which in turn affects (2) customer satisfaction and (3) eWOM behavior integrating the information processing theory. Furthermore, this paper analyzes (4) how customer innovativeness and owning cryptocurrency affect customers perceived transparency of the food supply chain. The moderation role of (5) food safety concerns and (6) health consciousness is also analyzed for BCT transparency. Study 1, a service design workshop, explored customers' motivation, pain points, and experiences from restaurants adopting BCT to track the supply chain of ingredients. Built upon findings from study 1, in study 2, data were collected from 518 restaurant customers who had dining-out experiences in the past three

months. The data were analyzed by partial least squares-structural equation modeling (PLS-SEM). The findings make an important contribution to the theoretical extension of information processing theory. The findings of this study can guide restaurant owners, policymakers, and technology developers in making informed decisions regarding the adoption of BCT in the restaurant industry.

2.Literature review

2.1 Blockchain Technology

BCT, a distributed ledger functioning as a peer-to-peer network, ensures data integrity and mitigates tampering and single points of failure (Queiroz et al., 2019). With its decentralized, immutable, secure, and transparent nature, BCT networks offer promising prospects for enhancing transparency in the food supply chain (Bumblauskas et al., 2020). By providing a decentralized, secure, and transparent platform for transactions, BCT eliminates information distortion and increases transparency (Duan et al., 2020). Its integration into the food supply chain allows authorized users to access comprehensive information about a food product's origin, ripeness, and temperature (Tsang et al., 2019). The consensus algorithm of BCT ensures the security and immutability of records, thereby reducing the risk of tampering and fostering trust among customers regarding the safety and quality of food products (Creydt & Fischer, 2019).

Numerous studies have demonstrated the significant improvement in transparency achieved through the implementation of BCT in the food supply chain. Zhao et al. (2019) proved the adoption of BCT, alongside ICT and the Internet of Things, for enhancing agri-food traceability management. Duan et al. (2020) found BCT as a means to enhance food traceability, information transparency, and recall efficiency within the food supply chain. Friedman and Ormiston (2022), through expert interviews across global food supply chains, emphasized the potential of BCT to improve transparency, ensure fairer supply chains, and promote environmental sustainability.

2.2 Information Processing Theory and Transparency

The information processing theory is a cognitive framework that seeks to understand how individuals acquire, process, store, and recall information from their environment (Lachman et al., 2015). It has been widely applied in various domains, including marketing, human-computer interaction, and technology acceptance (Tybout et al., 1981). According to this theory, individuals engage in sequential cognitive operations, such as attention, perception, encoding, storage, and retrieval, which enable the transformation of sensory input into meaningful information (Schlager, 2019). These cognitive processes have significant implications for cognitive development, learning, memory processes, decision-making, and efficient information processing.

In the context of the information processing theory, BCT plays a role in enhancing information processing capabilities (Dubey et al., 2020). When customers come across BCT-based food products, they are particularly drawn to the transparency that BCT offers (Kamilaris et al., 2019). Transparency is of utmost importance in the food industry as it enables the monitoring of food safety and quality throughout the supply chain, thereby restoring consumer confidence (Ringsberg, 2014). Customers perceive BCT as a guarantee for the assurance of

food products, which shapes their knowledge and beliefs (Dubey et al., 2020). These perceived attributes are encoded and stored in memory, ultimately influencing their evaluation of satisfaction and overall experience.

2.3 Food Safety, Food Quality, and Food Naturalness

Food safety, quality, and naturalness are crucial concerns in the restaurant industry. Ensuring the safety of food products is essential to protect public health and maintain the reputation of restaurants (Bai et al., 2019). According to information processing theory, BCT is a promising solution for improving transparency and reducing the risk of foodborne illness outbreaks. Hao et al. (2020) discovered that BCT can help prevent outbreaks and improve recall efficiency by tracking and monitoring food products in real time.

Food quality is critical for customer satisfaction and loyalty. When customers dine out in a restaurant, they expect food products that are safe, nutritious, and meet their expectations in terms of taste, texture, and appearance (Konuk, 2019). Zhao et al. (2020) found that the support vector machine (SVM) outperforms in tracking honey origins, which is useful for assessing food quality. By using innovative technologies, transparency can help enhance food quality and meet consumer expectations

Food naturalness is an increasing concern for consumers who seek minimally processed and additive-free food products (Konuk, 2019; Huang et al., 2022). The naturalness of food products is determined by various factors, including the origin of the ingredients, the processing methods used, and the presence of additives and preservatives (Siipi, 2013). According to information processing theory, transparency can help ensure the naturalness of food products by providing information about the origin and production methods of ingredients used in the manufacturing process (Duan et al., 2020). Jiménez-Carvelo et al. (2021) found that discriminant analysis successfully authenticates avocado samples in terms of geographical origins and cultivars. Therefore, the following hypotheses are proposed:

H1a. Transparency is positively related to perceived food safety.

H1b. Transparency is positively related to perceived food quality.

H1c. Transparency is positively related to perceived food naturalness.

2.4 Customer Satisfaction

Customer satisfaction within the restaurant industry encompasses the comprehensive evaluation conducted by customers, encompassing both the food products and service aspects, developed over their cumulative dining experiences over an extended period (Khan et al., 2022). Undoubtedly, customer satisfaction serves as an essential catalyst for achieving success in the restaurant sector, exerting a significant influence on financial gains, reputation establishment, and customer loyalty cultivation.

As aforementioned, the food product assumes a pivotal position in shaping customer satisfaction levels within a restaurant. Dsouza and Sharma (2021) found that implementing food safety measures in restaurants plays a crucial role in customer retention and fostering

loyalty. Zhong and Moon (2020) discovered that perceived food quality directly affects customer satisfaction in the fast-food restaurant context. Keller and Kostromitina (2020) found that food quality has a significant positive impact on customer satisfaction in non-chain restaurants. Huang et al. (2022) proved that a heightened perception of nutritional value enhances the perceived naturalness of food, subsequently influencing the intention to purchase healthy food items. Therefore, the following hypotheses are proposed:

H2a. Perceived food safety is positively related to customer satisfaction.

H2b. Perceived food quality is positively related to customer satisfaction.

H2c. Perceived food naturalness is positively related to customer satisfaction.

2.5 Electronic Word of Mouth (eWOM)

In recent years, the phenomenon of eWOM has experienced a remarkable upsurge of interest in the fields of marketing and consumer behavior. eWOM entails the dynamic and continuous exchange of information among previous, current, and potential consumers, specifically pertaining to products, services, brands, or companies (Lee et al., 2022; Donthu et al., 2021). This information is actively disseminated through diverse online channels, enabling its widespread reach and engagement with a diverse spectrum of individuals and establishments through the internet (Babić Rosario et al., 2020).

In the restaurant industry, eWOM plays a pivotal role due to its strong association with business performance as reflected in online customer reviews (Abdullah et al., 2022). Satisfied customers not only demonstrate loyalty and repeat purchases but also actively engage in recommending the brand to others (Dam & Dam, 2021). Konuk (2019) found that customer satisfaction significantly influences eWOM behavior within the domain of organic food restaurants. Quan et al. (2021) validated that the satisfaction of Chinese customers serves as a crucial driver for eWOM behavior in the context of Korean restaurants. Moreover, Almohaimmeed (2020) established a direct and meaningful connection between customer satisfaction and eWOM in the realm of Arabic restaurants. Therefore, the following hypotheses is proposed:

H3. Customer satisfaction is positively related to eWOM.

3. Study 1

Study 1 conducts a service design workshop to investigate how the adoption of BCTs in restaurants affects the dining experience of customers from different customer segments. Service design is an interdisciplinary approach that focuses on enhancing the human experience and utilizes creativity and iteration to develop innovative services (Holmlid & Evenson, 2008).

3.1 Research Design

The study included four facilitators and ten participants from the United States. Facilitators were responsible for providing information, assigning tasks, maintaining a positive atmosphere, encouraging participants, monitoring time, and minimizing interruptions. Participants were required to be at least 21 years old and have had dining experience within the past three months. The participants were divided into five groups. The study employed various customer persona scenarios with varying characteristics based on the dine-out scenario, self-telling stories, demographic information, technology innovativeness, and dietary backgrounds for each group. Persona sample was shown as Figure 1. The personas were carefully chosen to cover diverse customer backgrounds in order to comprehensively understand customer perceptions of BCT adoption in restaurants. Artificial intelligence-generated faces were used to represent each customer persona, and the workshop took place in a multimedia room where each participant was provided with sticky notes and pens. The workshop lasted for two hours, and all data and photographs were collected and archived for analysis.

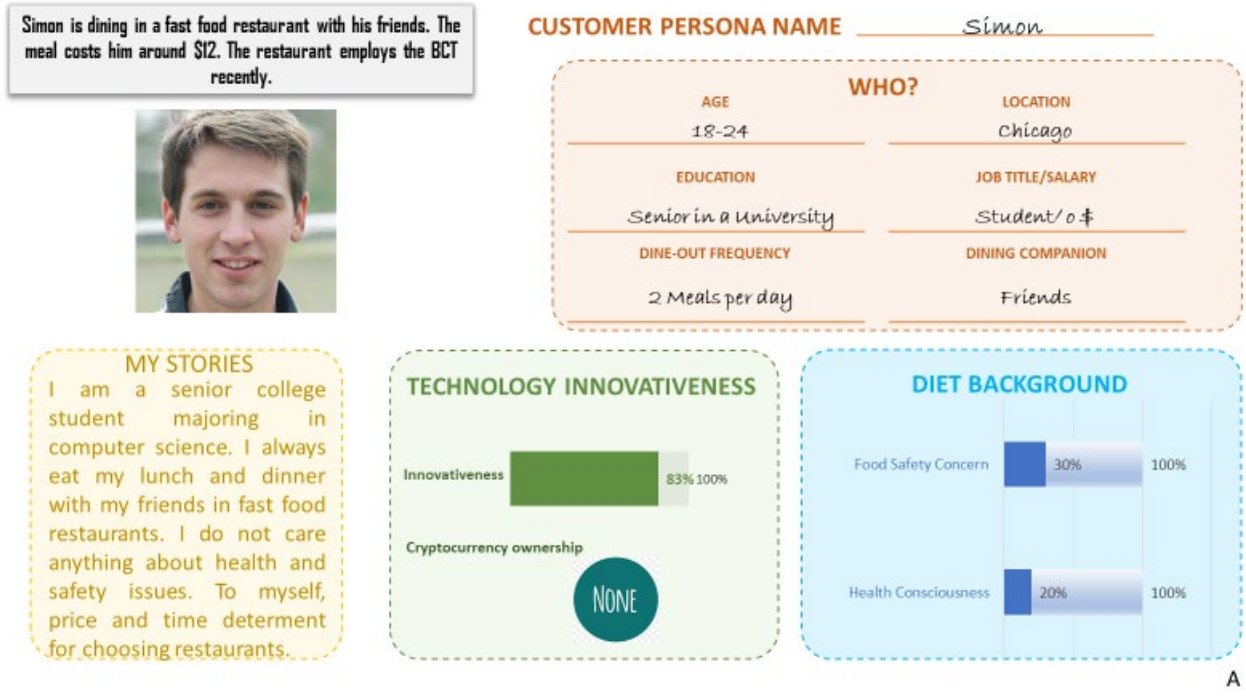

Figure 1. Persona sample (Simon)

3.2 Research Process

At the beginning of the workshop, the facilitators provided the participants with instructions on how to proceed. Participants were divided into five groups using a warm-up game, and each group was given a customer persona as mentioned before. Participants were instructed to imagine themselves as customers portrayed in the persona and brainstorm reasons why they would dine out at restaurants that have adopted BCTs. The facilitator allocated 20 minutes for each group to write down as many reasons as possible, with one item per note. The facilitator used a projected e-timer to count down the time and asked the groups if they faced any

difficulties. Once the time was up, each group pasted their notes on the whiteboard and read them aloud for 5 minutes. Participants were then directed to focus on the pain points of restaurants that use BCTs. The facilitator asked each group to write down all the pain points they could think of within 20 minutes, with one item per sticky note. Again, each group pasted their notes on the whiteboard and read them aloud for 5 minutes. Following that, the participants were instructed to rate their level of satisfaction with the use of BCTs in restaurants based on the previous discussion. The satisfaction levels ranged from extremely satisfied to extremely unsatisfied, using a 7-point Likert scale chart. The photos, videos, and notes from the activity were gathered and analyzed (see Figure 2).

Figure 2. Service design workshop

3.3 Results and Discussion

The study revealed that several factors, namely transparency, food safety, food quality, and food naturalness, were frequently mentioned as key considerations by customers when discussing the reasons why they choose BCT restaurants. Eight out of ten participants expressed that 'transparency' as a significant characteristic of BCT ensures the food products they consume. Direct notes from participants included statements such as 'knowing the food-making process,' 'knowing the origin and delivery process of raw fish and produce,' 'knowing the storage temperature of cold fish,' 'getting information about how long food has been in transit,' 'identifying the region or country of origin,' 'knowing how many people handled the products,' and 'tracking purposes.'

Ensuring the food products customers consume was mentioned. Participants highlighted food concerns related to safety (4 out of 10), quality (3 out of 10), and naturalness (5 out of 10). Firstly, food safety was considered crucial, with participants emphasizing the importance of 'sanitary conditions during the distribution process,' 'the cleanliness of fruits and vegetables,' and 'the way food is handled by people'. Secondly, food quality was identified as one of the most critical factors in adopting BCT, with participants stressing the importance of 'food freshness,' 'ingredient verification,' and 'assurance of organic food'. Thirdly, food naturalness was identified as an important factor that customers increasingly focus on, including 'the origin of food products,' 'the GMO status of ingredients,' and 'the type of pesticides used on fruits'. However, participants also noted some challenges in adopting BCT, such as potential increases in food prices, the time-consuming nature of the technology, and concerns over poor technology infrastructure. Overall, six out of ten participants rated their customer satisfaction, with four out of ten being neutral or less satisfied. These findings provide insights into the determinants of BCT that influence customer satisfaction during the dining experience.

More specifically, participants in the high innovativeness persona condition, as established by Simon and Lucas, emphasized the importance of BCT transparency significantly more than those in other conditions. This finding suggests that participants who are more open to adopting new technologies may be more receptive to the benefits of using BCT for increasing transparency and reducing information asymmetry in the restaurant industry. Similarly, participants in the holding cryptocurrency condition, as established by Lucas and Alice, perceived transparency significantly more than those without such experience. This finding suggests that individuals who are familiar with cryptocurrency may be more receptive to the benefits of using BCT for increasing transparency and reducing information asymmetry in the restaurant industry. Therefore, the following hypotheses are proposed:

H4a. Innovativeness is positively related to transparency.

H4b. Owning cryptocurrency is positively related to transparency.

Furthermore, the results showed an interesting phenomenon that participants in the group of personas with high food safety concerns address the safety aspect of the supply chain of food ingredients. Food safety concerns refer to the anxiety that consumers may experience regarding the contamination of food products, food temperature, and pathogens contained in food products, which can potentially compromise their physical health (Borchers et al., 2010). These concerns highlight the importance of ensuring that food products are safe and free from harmful contaminants throughout the food supply chain. Participants in the group of Sophia (95% out of 100%), Lucas (90% out of 100%), Alyssa (95% out of 100%), and Alice (80% out of 100%) emphasized that using BCT can access accurate and trustworthy information about the food they consume, while also facilitating the rapid identification and containment of foodborne disease outbreaks. Direct quotes from participants included statements such as ‘real-time track the cleanliness condition of distribution process’, ‘how many people deal with the food products’, and ‘monitor the temperature of cooking’. These findings align with the study

of Ahangarkolaee and Gorton (2020) that food safety concern enhances customers' willingness to pay for certified organic food. Therefore, the following hypothesis is proposed:

H5: Food safety concern moderate the path between the transparency and perceived food safety.

In a similar vein, the results showed the same as for the health consciousness. Health consciousness refers to the awareness and concern that individuals have about their health and well-being (Xu et al., 2020). With the increasing prevalence of chronic diseases and the growing interest in preventive health measures, health consciousness has become an important aspect of public health and healthcare. Participants in the group of Sophia (90% out of 100%), Lucas (85% out of 100%), Alyssa (70% out of 100%), and Alice (70% out of 100%) emphasized that using BCT can enable real-time monitoring of food products, which can help to identify quality issues or problems with freshness and shelf life. Direct quotes from participants included statements such as 'assurance organic food products', 'check the freshness', and 'detect the shelf life of food products'. These findings align with the study of Testa et al. (2019) that health consciousness has a positive effect on attitudes toward buying organic food. Therefore, the following hypothesis is proposed (see Fig. 3):

H6: Health consciousness moderate the path between the transparency and perceived food quality.

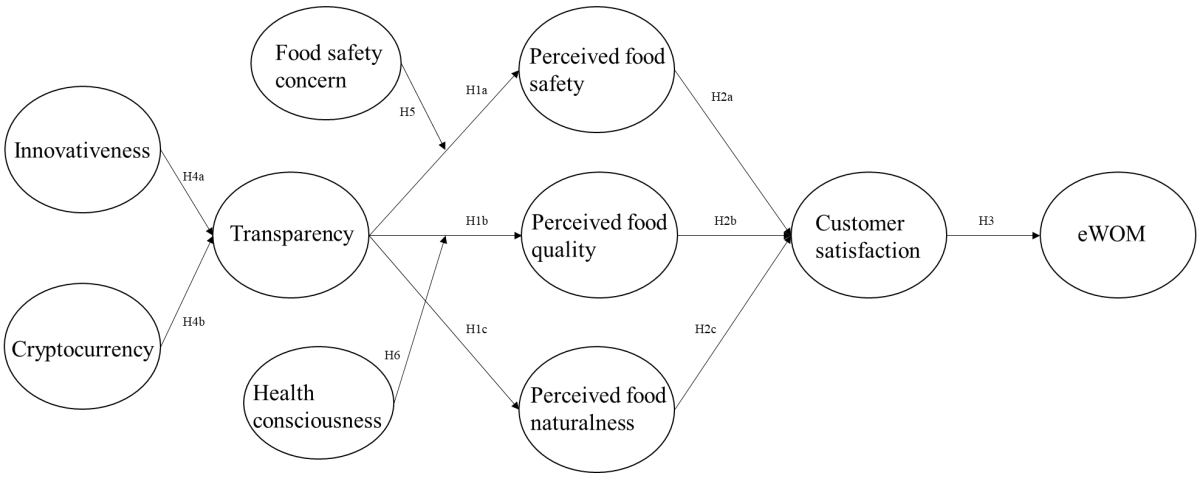

Figure 3. Conceptual model

4. Study 2

Study 2 examines hypotheses H1-H6 to investigate how the transparency of BCT influences customer dining experience and eWOM behavior. Transparency is expected positively related to food safety (H1a), food quality (H1b), and food naturalness (H1c). Food safety, quality, and naturalness are then predicted to be positively related to customer satisfaction (H2a, H2b, H2c). Customer satisfaction is predicted to have a positive relationship with eWOM (H3). Furthermore, innovativeness and owning cryptocurrency are predicted to be positively related to transparency (H4a, H4b). Food safety concern is predicted to moderate the relationship between transparency and perceived food safety (H5). Health consciousness is predicted to moderate the relationship between transparency and perceived food quality (H6).

4.1 Research Design and Data Collection

The study was designed and distributed online through the Qualtrics platform. We included a scenario background, restaurant picture, menu with BCT labels, and food pictures to visualize the dining experience in a BCT restaurant. We asked participants to imagine themselves dining in a restaurant that had adopted BCT. The survey took approximately 15 minutes to complete. Data were collected through Amazon Mechanical Turk (MTurk), an online crowdsourcing platform, without specific geographical restrictions. Eligible participants were 21 years or older and had experience dining out in the past three months. Filter questions were designed to exclude irrelevant participants. A pilot study was conducted with 50 participants, which resulted in slight changes to the wording of the measurement items for better clarity. One attention check question was included to enhance data quality. A total of 569 respondents participated in the study, and 51 responses were removed due to failure to pass the attention check questions. The final sample size was 518. Table 1 illustrates the characteristics of the participants.

Table 1. Profiles of participants

Category	Frequency	Percent	Category	Frequency	Percent
Gender			**Age**		
Male	291	56.17	Baby boomers (Born between 1946-1964)	18	3.47
Female	227	43.83			
			Generation X (Born between 1965-1981)	66	12.74
			Generation Y (Born between 1982-2000)	421	81.27
Education					
High school	47	9.07	Generation Z (Born after 2000)	13	2.52
2-year technical college	34	6.56			
4-year bachelor's degree	274	52.90			
Master's degree	156	30.12	**Dietary restrictions**		
Doctorate degree	6	1.16	Lactose intolerance	30	5.79
Other	1	0.19	Gluten intolerance or sensitivity	19	3.67
			Vegetarianism	140	27.03
			Veganism	85	16.41
			Kosher	16	3.09
Income			Keto	17	3.28

			Diabetes	41	7.92
Less than USD 20,000	23	4.44	Dairy-free	10	1.93
USD 20,000-29,999	57	11.00	Low carb	10	1.93
USD 30,000-39,999	108	20.85	Food allergies	30	5.79
USD 40,000-49,999	176	33.98	N/A	11	2.12
USD 50,000 or more	154	29.73	Others	109	21.04

4.2 Measurement

Ten constructs were investigated based on the findings from Study 1, and all the measurement items were adopted from validated scales. Perceived transparency was measured using six items from Kamilaris et al. (2019) and Yuan et al. (2020). Perceived food safety was measured using four items developed by Rijswijk and Frewer (2008). For perceived food quality, four items were adopted from Konuk (2019). Perceived food naturalness was measured using four items borrowed from Roman et al. (2017). Customer satisfaction was measured using four items developed by Ali and Omar (2014). eWOM (electronic word-of-mouth) was measured using four items developed by Tsao and Hsieh (2012). Food safety concern and health consciousness were measured using four items and three items respectively, both developed by Anastasiadis et al. (2022). Innovativeness was measured using three items developed by Parasuraman et al. (2015). All items were measured on a seven-point Likert scale, ranging from 1 = strongly disagree to 7 = strongly agree.

4.3 Data Analysis

The data structure was analyzed using partial least squares-structural equation modeling (PLS-SEM), which combines principal component analysis and ordinary least squares regressions (Manley, 2021). PLS-SEM is a method developed to test partial model structures and offers advantages in analyzing more complex model structures for theory extension or integration (Hair et al., 2019). This study employed information processing theory to explore the explanatory and predictive power of ten antecedents on the focal construct; thus, PLS was more suitable for the phenomenon under investigation.

All indicators achieved loadings of approximately 0.708 or higher (see Table 2). The reliability and internal consistency of the measurement model were assessed using Cronbach's alpha (α), Joreskog's rho (rho_A), and composite reliability (CR) (Hair et al., 2019). All constructs demonstrated strong reliability and internal consistency, with α, rho_A, and CR values ranging from 0.7 to 0.9. Convergent validity was evaluated using the average variance extracted (AVE), with all constructs achieving an AVE above 0.5, indicating acceptable convergent validity. Discriminant validity was assessed using the heterotrait-monotrait (HTMT) ratio, with all HTMT values below 0.90, indicating acceptable discriminant validity.

The structural model was assessed using the coefficient of determination (R2), with substantial, moderate, and weak values being defined as 0.75, 0.50, and 0.25, respectively (Hair et al., 2019). The results indicate that the R2 of PFS is moderate, with a value of 0.655 falling within the moderate range of 0.50-0.75. Similarly, the R2 of PFQ, PFN, SAT, and EWOM are moderate, with values of 0.735, 0.627, 0.646, and 0.734, respectively, all falling within the moderate range of 0.50-0.75.

Table 2. Indicator loadings, Internal consistency reliability, and convergent validity

Constructs	Items	Loadings	α	rho_A	CR	AVE
eWOM			0.775	0.774	0.855	0.597
	EWOM_1	0.754				
	EWOM_2	0.761				
	EWOM_3	0.788				
	EWOM_4	0.787				
Satisfaction			0.757	0.760	0.846	0.579
	SAT_1	0.725				
	SAT_2	0.782				
	SAT_3	0.781				
	SAT_4	0.753				
Food safety			0.746	0.747	0.840	0.568
	PFS_1	0.717				
	PFS_2	0.776				
	PFS_3	0.741				
	PFS_4	0.778				
Food quality			0.773	0.776	0.855	0.596
	PFQ_1	0.722				
	PFQ_2	0.806				
	PFQ_3	0.758				
	PFQ_4	0.798				
Food naturalness			0.800	0.808	0.863	0.558
	PFN_1	0.781				
	PFN_2	0.716				
	PFN_3	0.779				
	PFN_4	0.797				
Transparency			0.867	0.869	0.897	0.521
	TRA_1	0.708				
	TRA_2	0.718				
	TRA_3	0.753				
	TRA_4	0.746				
	TRA_5	0.783				
	TRA_6	0.762				
Innovativeness			0.753	0.761	0.844	0.576
	INN_1	0.749				
	INN_2	0.761				
	INN_3	0.831				
Food safety concern			0.799	0.807	0.869	0.625
	FSC_1	0.729				
	FSC_2	0.776				
	FSC_3	0.826				
	FSC_4	0.827				
Health consciousness			0.765	0.772	0.850	0.587
	HC_1	0.785				
	HC_2	0.800				
	HC_3	0.783				

Note(s): α = Cronbach's alpha; rho_A = Joreskog's rho; CR= composite reliability; AVE = average variance extracted.

4.4 Results and Discussion

Hypotheses were evaluated in the structural model, and the relationship between hypothesized constructs was investigated (see Table 3). H1a (TRA → PFS) indicated that transparency has a positive and significant impact on perceived food safety ($\beta = 0.636$, $P < 0.01$). H1b (TRA → PFQ) showed that transparency has a positive and significant impact on perceived food quality ($\beta = 0.403$, $P < 0.01$). H1c (TRA → PFN) suggested that transparency has a positive and significant impact on perceived food naturalness ($\beta = 0.791$, $P < 0.01$). These findings are consistent with previous research that highlights the importance of BCT adoption in food products and its ability to increase customer food perceptions by enabling the tracking of food items (Treiblmaier & Garaus, 2023). Transparency is an antecedent to food safety, quality, and naturalness because BCT can help identify and trace potential contamination issues, ensure proper storage and transportation conditions, and track food origin to identify ingredients (Duan et al., 2020).

H2a (PFS → SAT) revealed a positive and significant relationship between perceived food safety and customer satisfaction ($\beta = 0.379$, $P < 0.01$). H2b (PFQ → SAT) indicated a positive and significant relationship between perceived food quality and customer satisfaction ($\beta = 0.328$, $P < 0.01$). H2c (PFN → SAT) suggested a positive and significant relationship between perceived food naturalness and customer satisfaction ($\beta = 0.231$, $P < 0.01$). These findings posit that fulfilling commitments to food safety, quality, and naturalness strengthens customer satisfaction in restaurants. H3 (SAT → EWOM) demonstrated a positive and significant relationship between customer satisfaction and eWOM behavior ($\beta = 0.829$, $P < 0.01$), indicating that when customers feel satisfied a restaurant, they are more likely to post positive online restaurant reviews.H4a (INN → TRA) portrayed a positive and significant relationship between innovativeness and transparency ($\beta = 0.737$, $P < 0.01$). H4b (CYPTO → TRA) suggested a positive and significant impact of cryptocurrency on transparency ($\beta = 0.477$, $P < 0.01$), suggesting that customer innovativeness and experience with digital currencies play a crucial role in building customer perceptions of transparency of BCT to track the food ingredients.

H5 (FSC*TRA → PFS) revealed that food safety concern strengthens the association between transparency and perceived food safety ($\beta=0.168$, $P<0.01$). Similarly, H6 (HC*TRA → PFQ) indicated that health consciousness strengthens the relationship between transparency and perceived food quality ($\beta=0.426$, $P<0.01$). The fifth finding confirms that the implementation of BCT (TRA) is an effective way for restaurants to build their reputation in terms of food safety, and customers' food safety concerns strengthen the proposed associations. The results suggest that food safety concern moderates the association, indicating that customers' food safety concern plays a significant role in fostering perceived food safety. The results found that when consumers have a high level of food safety concern, the effect of BCT transparency on perceived food safety is stronger compared to those with lower levels of concern. This suggests that consumers who are more concerned about food safety may be more attentive to the transparency provided by BCT in the restaurant industry. Conversely, when consumers have a low level of food safety concern, the effect of BCT transparency on perceived food safety is weaker. Therefore, the restaurant needs to consider the level of food safety

concern among their consumers when implementing BCT to increase transparency. Similarly, H6 reveals a supporting result as health consciousness strengthens the association between transparency and perceived food quality. The results found that when consumers have a high level of health consciousness, the effect of BCT transparency on perceived food quality is stronger compared to those with lower levels of consciousness. This suggests that consumers who have higher health consciousness may be more attentive to the transparency provided by BCT in the restaurant industry.

Table 3. Hypotheses tests

Hypotheses	Relationships	β	SD	T	P	Results
H1a	TRA -> PFS	0.636***	0.061	10.391	0.000	Supported
H1b	TRA -> PFQ	0.403***	0.060	6.698	0.000	Supported
H1c	TRA -> PFN	0.791***	0.028	28.302	0.000	Supported
H2a	PFS -> SAT	0.379***	0.059	6.453	0.000	Supported
H2b	PFQ -> SAT	0.328***	0.059	5.526	0.000	Supported
H2c	PFN -> SAT	0.231***	0.058	4.008	0.000	Supported
H3	SAT -> EWOM	0.829***	0.023	36.472	0.000	Supported
H4a	INN -> TRA	0.737***	0.035	21.255	0.000	Supported
H4b	CRY -> TRA	0.477***	0.071	6.710	0.000	Supported
H5	FSC x TRA-> PFS	0.168***	0.050	3.359	0.001	Supported
H6	HC x TRA -> PFQ	0.426***	0.058	7.326	0.000	Supported

Note(s): β = unstandardized coefficient; SD=Standard deviation; T = T statistics; P = P values; * P ⩽ 0.05, ** P ⩽ 0.01, *** P ⩽ 0.001.

5. Conclusion

5.1 Theoretical Implications

This study provides significant theoretical contributions to the literature on tourism and hospitality by focusing on BCT adoption in the restaurant industry. Specifically, this study examines the impact of BCT transparency on perceived food safety, food quality, and food naturalness in the restaurant dining experience. Previous research has indicated that food transparency has a positive influence on food safety, reduces food waste issues, and enhances supply chain management (Yu et al., 2022; Marin et al., 2021; Gayialis et al., 2022). However, this study extends the current research scope by demonstrating that the transparency of BCT has a strong impact on perceived food safety, quality, and naturalness in restaurants. In addition, this study analyzes the direct effect of perceived food safety, quality, and naturalness on customer satisfaction, finding that perceived food safety, quality, and naturalness have a positive influence on customer satisfaction based on the information processing theory (Schlager, 2019).

Second, the study highlights the potential of service design workshops as a methodology for understanding customer preferences in the restaurant industry. A service

design workshop is a collaborative process that brings together stakeholders to design and innovate service experiences that meet the needs and expectations of customers (Font et al., 2021). The workshop can also help identify pain points and areas of improvement in existing service experiences, leading to more effective and efficient service delivery (Webb, 2016). Service design workshops can serve as useful tools in designing and implementing new services or technologies in the restaurant industry.

Third, the study contributes to the understanding of the relationship between food safety concerns and health consciousness and the perceived transparency of BCT. The findings suggest that consumers who are more concerned about food safety and have higher health consciousness may be more attentive to the transparency provided by BCT in the restaurant industry. Restaurants may consider the level of food safety concern and health consciousness among their consumers when implementing BCT to increase transparency.

5.2 Managerial Implications

This study's results are expected to have practical implications for restaurant managers, marketers, and developers of BCT tracking systems. As customers increasingly demand food safety and quality, restaurants can enhance customer satisfaction by improving transparency to inform them about the origin, intermediaries, and distribution process of the entire supply chain (Duan et al., 2020).

For restaurant establishments, information transparency related to food products is crucial. This study found that transparency significantly influences customer satisfaction thereby affecting eWOM behavior. Thus, restaurant managers can promote adopting BCT tracking systems in restaurants to demonstrate how food flows during the supply chain and enhance safety, quality, and naturalness perceptions in food consumption, thereby increasing customer satisfaction and eWOM behavior. Moreover, the study highlights the strong impact of customer satisfaction on eWOM behavior in restaurants. Restaurant managers can utilize the BCT tracking system to build reassuring experiences to establish transparent relationships between customers and restaurants, thereby creating a competitive advantage.

Furthermore, BCT tracking system developers can optimize the system's functions and focus on enhancing its user-friendliness. Several ways can improve the efficient use of BCT tracking systems, such as creating a realistic and relatable system, being transparent about data input, and providing useful information for customer needs (Srivastava & Dashora 2022; Rauniyar et al., 2022). By taking these steps, restaurants can build stronger relationships with customers and create a more trustworthy environment for the dining experience. Additionally, restaurants can ensure that their customers have a positive experience with BCT-based services and are more likely to revisit them in the future.

5.3 Limitations

This study has a few limitations. Firstly, the data were collected through a self-report survey, which may have introduced common method bias. To mitigate this issue, we suggest that future studies adopt a multi-source data collection approach to eliminate same-source variance. Secondly, future research could consider conducting field experiments and incorporating eye-tracking and EEG technology to gain a more comprehensive understanding of customers' real-time responses to BCT and to track ingredient supply chains.

6. References

Ali, F., & Omar, R. (2014). Determinants of customer experience and resulting satisfaction and revisit intentions: PLS-SEM approach towards Malaysian resort hotels. *Asia-Pacific Journal of Innovation in Hospitality and Tourism*, *3*(2), 1–19.

Anastasiadis, F., Manikas, I., Apostolidou, I., & Wahbeh, S. (2022). The role of traceability in end-to-end circular agri-food supply chains. *Industrial Marketing Management*, *104*, 196-211.

Almohaimmeed, B. M. (2020). The impacts of brand experiences on customer satisfaction and electronic word of mouth. *Verslas: teorija ir praktika*, *21*(2), 695-703.

Abdullah, S., Van Cauwenberge, P., Vander Bauwhede, H., & O'Connor, P. (2022). User-generated reviews and the financial performance of restaurants. *International Journal of Contemporary Hospitality Management*, (ahead-of-print).

Boehler, P. (2012, November 6). *Bad eggs: Another fake-food scandal rocks China*. Time. https://newsfeed.time.com/2012/11/06/how-to-make-a-rotten-egg/

Bosona, T., & Gebresenbet, G. (2013). Food traceability as an integral part of logistics management in food and agricultural supply chain. *Food Control*, *33*(1), 32-48.

Bai, L., Wang, M., Yang, Y., & Gong, S. (2019). Food safety in restaurants: The consumer perspective. *International Journal of Hospitality Management*, *77*, 139–146. https://doi.org/10.1016/j.ijhm.2018.06.023

Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. (2020). A blockchain use case in food distribution: Do you know where your food has been? *International Journal of Information Management*, *52*, 102008. https://doi.org/10.1016/j.ijinfomgt.2019.09.004

Babić Rosario, A., De Valck, K., & Sotgiu, F. (2020). Conceptualizing the electronic word-of-mouth process: What we know and need to know about eWOM creation, exposure, and evaluation. *Journal of the Academy of Marketing Science*, *48*, 422-448.

CBS Interactive. (2016, January 4). *Don't fall victim to olive oil fraud*. CBS News. https://www.cbsnews.com/news/60-minutes-overtime-how-to-buy-olive-oil/

CBC/Radio Canada. (2017, February 28). *50% chicken DNA: Why your favourite fast food chicken sandwich might not be what you ordered | CBC news*. CBCnews. https://www.cbc.ca/news/business/marketplace-chicken-fast-food-1.3993967

Creydt, M., & Fischer, M. (2019). Blockchain and more-Algorithm driven food traceability. *Food Control*, *105*, 45-51.

Dubey, R., Gunasekaran, A., Bryde, D. J., Dwivedi, Y. K., & Papadopoulos, T. (2020). Blockchain technology for enhancing swift-trust, collaboration and resilience within a humanitarian supply chain setting. *International journal of Production research*, *58*(11), 3381-3398.

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020). A content-analysis based literature review in blockchain adoption within food supply chain. *International Journal of Environmental Research and Public Health*, *17*(5), 1784.

Dam, S. M., & Dam, T. C. (2021). Relationships between service quality, brand image, customer satisfaction, and customer loyalty. *The Journal of Asian Finance, Economics and Business*, *8*(3), 585-593.

Davies, C. R., Wohlgemuth, F., Young, T., Violet, J., Dickinson, M., Sanders, J. W., ... & Avery, S. V. (2021). Evolving challenges and strategies for fungal control in the food supply chain. *Fungal Biology Reviews*, *36*, 15-26.

Dsouza, D., & Sharma, D. (2021). Online food delivery portals during COVID-19 times: an analysis of changing consumer behavior and expectations. *International Journal of Innovation Science*, *13*(2), 218-232.

Donthu, N., Kumar, S., Pandey, N., Pandey, N., & Mishra, A. (2021). Mapping the electronic word-of-mouth (eWOM) research: A systematic review and bibliometric analysis. *Journal of Business Research*, *135*, 758-773.

Font, X., English, R., Gkritzali, A., & Tian, W. S. (2021). Value co-creation in sustainable tourism: A service-dominant logic approach. *Tourism Management*, *82*, 104200.

Friedman, N., & Ormiston, J. (2022). Blockchain as a sustainability-oriented innovation?: Opportunities for and resistance to Blockchain technology as a driver of sustainability in global food supply chains. *Technological Forecasting and Social Change*, *175*, 121403. https://doi.org/10.1016/j.techfore.2021.121403

Guardian News and Media. (2013, January 31). *Burger King reveals its burgers were contaminated in horsemeat scandal*. The Guardian. https://www.theguardian.com/business/2013/jan/31/burger-king-horsemeat

Gayialis, S. P., Kechagias, E. P., Papadopoulos, G. A., & Masouras, D. (2022). A review and classification framework of traceability approaches for identifying product supply chain counterfeiting. *Sustainability*, *14*(11), 6666.

Holmlid, S., & Evenson, S. (2008). Bringing service design to service sciences, management and engineering. *Service Science, Management and Engineering Education for the 21st Century*, 341-345.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2-24.

Hao, Z., Mao, D., Zhang, B., Zuo, M., & Zhao, Z. (2020). A Novel Visual Analysis Method of Food Safety Risk Traceability Based on Blockchain. *International Journal of Environmental Research and Public Health*, *17*(7), Article 7. https://doi.org/10.3390/ijerph17072300

Huang, Z., Zhu, Y.-D., Deng, J., & Wang, C.-L. (2022). Marketing Healthy Diets: The Impact of Health Consciousness on Chinese Consumers' Food Choices. *Sustainability*, *14*(4), Article 4. https://doi.org/10.3390/su14042059

Jiménez-Carvelo, A. M., Martín-Torres, S., Ortega-Gavilán, F., & Camacho, J. (2021). PLS-DA vs sparse PLS-DA in food traceability. A case study: Authentication of avocado samples. *Talanta*, *224*, 121904. https://doi.org/10.1016/j.talanta.2020.121904

Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. *Trends in Food Science & Technology*, *91*, 640-652.

Konuk, F. A. (2019). The influence of perceived food quality, price fairness, perceived value and satisfaction on customers' revisit and word-of-mouth intentions towards organic food restaurants. *Journal of Retailing and Consumer Services*, *50*, 103–110. https://doi.org/10.1016/j.jretconser.2019.05.005

Keller, D., & Kostromitina, M. (2020). Characterizing non-chain restaurants' Yelp star-ratings: Generalizable findings from a representative sample of Yelp reviews. *International Journal of Hospitality Management*, *86*, 102440.

Khan, R. U., Salamzadeh, Y., Iqbal, Q., & Yang, S. (2022). The impact of customer relationship management and company reputation on customer loyalty: The mediating role of customer satisfaction. *Journal of Relationship Marketing*, *21*(1), 1-26.

Lachman, R., Lachman, J. L., & Butterfield, E. C. (2015). *Cognitive psychology and information processing: An introduction*. Psychology Press.

Lee, W. L., Liu, C. H., & Tseng, T. W. (2022). The multiple effects of service innovation and quality on transitional and electronic word-of-mouth in predicting customer behaviour. *Journal of Retailing and Consumer Services*, *64*, 102791.

Marin, M. P., Marin, I., & Vidu, L. (2021). Learning about the reduction of food waste using blockchain technology. *arXiv preprint arXiv:2101.02026*.

Manley, S. C., Hair, J. F., Williams, R. I., & McDowell, W. C. (2021). Essential new PLS-SEM analysis methods for your entrepreneurship analytical toolbox. *International Entrepreneurship and Management Journal*, *17*, 1805-1825.

Parasuraman, A., & Colby, C. L. (2015). An updated and streamlined technology readiness index: TRI 2.0. *Journal of service research*, *18*(1), 59-74.

Queiroz, M. M., & Wamba, S. F. (2019). Blockchain adoption challenges in supply chain: An empirical investigation of the main drivers in India and the USA. *International Journal of Information Management*, *46*, 70-82.

Quan, W., Al-Ansi, A., & Han, H. (2021). Spatial and human crowdedness, time pressure, and Chinese traveler word-of-mouth behaviors for Korean restaurants. *International Journal of Hospitality Management*, *94*, 102851.

Ringsberg, H. (2014). Perspectives on food traceability: a systematic literature review. *Supply Chain Management: An International Journal*, *19*(5/6), 558-576.

Román, S., Sánchez-Siles, L. M., & Siegrist, M. (2017). The importance of food naturalness for consumers: Results of a systematic review. *Trends in Food Science & Technology*, *67*, 44–57. https://doi.org/10.1016/j.tifs.2017.06.010

Rana, R. L., Tricase, C., & De Cesare, L. (2021). Blockchain technology for a sustainable agri-food supply chain. *British Food Journal*.

Rauniyar, K., Wu, X., Gupta, S., Modgil, S., & de Sousa Jabbour, A. B. L. (2022). Risk management of supply chains in the digital transformation era: contribution and challenges of blockchain technology. *Industrial Management & Data Systems*, *123*(1), 253-277.

Siipi, H. (2013). Is Natural Food Healthy? *Journal of Agricultural and Environmental Ethics*, *26*(4), 797–812. https://doi.org/10.1007/s10806-012-9406-y

Schlager, E. (2019). A comparison of frameworks, theories, and models of policy processes. In *Theories of the Policy Process, Second Edition* (pp. 293-319). Routledge.

Shahabi Ahangarkolaee, S., & Gorton, M. (2021). The effects of perceived regulatory efficacy, ethnocentrism and food safety concern on the demand for organic food. *International Journal of Consumer Studies*, *45*(2), 273-286.

Srivastava, A., & Dashora, K. (2022). Application of blockchain technology for agrifood supply chain management: A systematic literature review on benefits and challenges. *Benchmarking: An International Journal*.

Tybout, A. M., Calder, B. J., & Sternthal, B. (1981). Using Information Processing Theory to design marketing strategies. *Journal of Marketing Research*, *18*(1), 73-79.

Tsao, W. C., & Hsieh, M. T. (2012). Exploring how relationship quality influences positive eWOM: The importance of customer commitment. *Total Quality Management & Business Excellence*, *23*(7-8), 821–835. https://doi.org/10.1080/14783363.2012.661137

Tsang, Y. P., Choy, K. L., Wu, C. H., Ho, G. T. S., & Lam, H. Y. (2019). Blockchain-driven IoT for food traceability with an integrated consensus mechanism. *IEEE access*, *7*, 129000-129017.

Testa, F., Sarti, S., & Frey, M. (2019). Are green consumers really green? Exploring the factors behind the actual consumption of organic food products. *Business Strategy and the Environment*, *28*(2), 327-338.

Treiblmaier, H., & Garaus, M. (2023). Using blockchain to signal quality in the food supply chain: The impact on consumer purchase intentions and the moderating effect of brand familiarity. *International Journal of Information Management*, *68*, 102514.

Van Rijswijk, W., & Frewer, L. J. (2008). Consumer perceptions of food quality and safety and their relation to traceability. *British Food Journal*.

Webb, N. (2016). *What customers crave: How to create relevant and memorable experiences at every touchpoint*. Amacom.

World Health Organization. (n.d.). *Estimates of the global burden of foodborne diseases*. World Health Organization. https://www.who.int/multi-media/details/estimates-of-the-global-burden-of-foodborne-diseases

Xu, X., Wang, S., & Yu, Y. (2020). Consumer's intention to purchase green furniture: Do health consciousness and environmental awareness matter?. *Science of the Total Environment*, *704*, 135275.

Yuan, C., Wang, S., & Yu, X. (2020). The impact of food traceability system on consumer perceived value and purchase intention in China. *Industrial Management & Data Systems*.

Yu, Z., Jung, D., Park, S., Hu, Y., Huang, K., Rasco, B. A., ... & Chen, J. (2022). Smart traceability for food safety. *Critical Reviews in Food Science and Nutrition*, *62*(4), 905-916.

Zulfakar, M. H., Anuar, M. M., & Ab Talib, M. S. (2014). Conceptual framework on halal food supply chain integrity enhancement. *Procedia-Social and Behavioral Sciences*, *121*, 58-67.

Zhong, R., Xu, X., & Wang, L. (2017). Food supply chain management: systems, implementations, and future research. *Industrial Management & Data Systems*.

Zhong, Y., & Moon, H. C. (2020). What drives customer satisfaction, loyalty, and happiness in fast-food restaurants in China? Perceived price, service quality, food quality, physical environment quality, and the moderating role of gender. *Foods*, *9*(4), 460.

Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2019). Blockchain technology in agri-food value chain management: A synthesis of

applications, challenges and future research directions. *Computers in Industry*, *109*, 83–99. https://doi.org/10.1016/j.compind.2019.04.002.

Zhao, Z., Chen, L., Liu, F., Zhou, F., Peng, J., & Sun, M. (2020). Fast Classification of Geographical Origins of Honey Based on Laser-Induced Breakdown Spectroscopy and Multivariate Analysis. *Sensors*, *20*(7), Article 7. https://doi.org/10.3390/s20071878