

Article

The Impact of Service Quality on Perceived Value, Image, Satisfaction, and Revisit Intention in Robotic Restaurants for Sustainability

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Abstract

Adoption of the use of robots in the foodservice industry has increased, and research in the quality of service provided by robots is required. Our research objective is to determine interrelationships among service quality, perceived value, restaurant image, satisfaction, and revisit intentions among customers at robotic restaurants. Data collection was conducted, with 342 South Korean restaurant consumers considered suitable to offer accurate responses to the survey questions. An online survey was employed to examine hypothesized relationships. Data analysis used descriptive statistics, confirmatory factor analysis, and structural equation modeling. Three dimensions of service quality (atmosphere quality, food quality, and interaction quality) at robotic restaurants were critical for higher perceived value by diners at robotic restaurants. Perceived value increases robotic restaurant image, customer satisfaction, and customer revisit intention. Additionally, findings reveal that robotic restaurant image is a positive predictor of satisfaction, and that satisfaction is a positive predictor of revisit intention. Robotic restaurants have become pervasive in hospitality service environments. Accordingly, theoretical and empirical findings about multiple dimensions of service quality in this context likely will be of interest to marketing researchers and practitioners for sustainable restaurant business.

Keywords: robotic restaurants; service quality; perceived value; restaurant image; satisfaction; revisit intention



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1. Introduction

Consumers' expectations about service quality have increased in the past few decades [1]. Currently, consumers are exposed to widespread access to information technologies; progressive consumers in particular prefer technology-driven services [2,3]. There is a movement to adopt new technology services in the hospitality industry involving a common set of tools, including robots, artificial intelligence, and service automation (RAISA), to satisfy consumers' new expectations and to enhance the sustainability of restaurant businesses by reducing reliance on human resources [4–6]. Robot chefs are beginning to appear in real restaurants, replacing human chefs in well-known examples including Spyce Kitchen (healthy bowl meals) in Boston, Flippy (a burger flipping robot) in the US, and Moley in the UK [7,8]. These robot chefs and servers can provide 24/7 service availability and solve labor shortages by reducing employees' perceived workload from labor intensive tasks [9], thereby improving both employee and consumer satisfaction. The adoption of

robots not only helps reduce costs but also increases productivity, efficiency, and reliability of services [10]. COVID-19 emphasized the role of non-contact technology services, with some consumers perceiving that human service delivery and interaction is vulnerable to compromise due to health and safety concerns [11,12]. Emerging infectious diseases continue to pose a threat due to factors such as increasing mobility and globalization, as well as climate change [13,14]. Robots have been proposed as a novel solution to these challenges to decrease human contact with viruses but increase social connection [15].

It is evident that service quality provided by service robots in restaurant settings is distinguishable from service quality provided by humans. Naumov (2019) insists that implementation of RAISA in tourism and hospitality industries has changed consumer perceptions toward service quality and satisfaction from “how” service is provided to “what” services are provided [1]. While consumer experience is an important business factor, with the introduction of RAISA, process innovation (e.g., efficiency and speed of service) and product innovation have become critical [1,3]. How robot service quality is composed and how it could lead to behavioral intentions in consumers must be researched in the era of RAISA. Nevertheless, there is limited research in robot service quality in the context of the foodservice industry. Unlike ample existing research in service quality provided by humans, research in the service quality of robots in restaurants is scarce [16]. Previous research on consumer-facing robotics tends to be conceptual and theoretical because the extent of consumers’ real experiences with robots is limited [17,18], and empirical research is less available [19]. This paper contributes to our understanding of the importance of service quality of robotic restaurants insofar as service quality management is an acknowledged strategic advantage in competitive contexts [20].

In general, perceptions of high service quality by customers affect the processes whereby customers form positive values about restaurants. Superior value can be a competitive edge for any company in securing consumer satisfaction [21–24], and foodservice business operations are no exception in their efforts to improve perceived value. This conceptualization of the impact of service quality on perceived value can be applied in the robotic restaurant context. In addition, previous studies have determined that an increase in perceived value increases the image of a restaurant [25,26]. According to existing studies [21,27–29], service quality, perceived value, and restaurant image are essential drivers of satisfaction and behavioral intentions in customers. Although extensive research has addressed these constructs, empirical examination of interrelationships between satisfaction and behavioral intentions and associated variables within the robotic restaurant industry is limited.

Thus, this paper aims to investigate causal associations among service quality at robotic restaurants and perceived value, restaurant image, satisfaction, and revisit intentions among customers. In detail, it examines (1) the influences of four dimensions of service quality (atmosphere quality, food quality, service quality, and interaction quality) at robotic restaurants on customers’ perceived value, (2) the influence of perceived value on robotic restaurant image, satisfaction, and robotic restaurant revisit intentions in customers, and (3) the impact of robotic restaurant image on satisfaction and the impact of customer satisfaction on their revisit intentions.

2. Theoretical Background

2.1. Service Quality of Robotic Restaurants

Service robots in front line service settings refer to system-based interfaces possessing the capability to interact, communicate, and deliver services to consumers through autonomous decision-making processes [30]. Service quality provided by humans focuses on the degree of discrepancy between consumers’ expectations toward service and actual

delivery [31]; in this way, perceived quality is measured based on the difference between consumers' assessments of the actual service performance relative to the expectation.

The studies that do exist have tended to focus on service quality of restaurant robots [32,33]. The work of Morita et al. (2020) applies five dimensions (responsiveness, assurance, empathy, reliability, and tangibles) of service quality to robot cafés using SERVQUAL, the classic multidimensional research instrument designed to capture consumers' expectations and perceptions of service [34]. Choi et al. (2020) explored consumer perceptions toward human–robot interactions and compared perceptions of interaction quality, outcome quality, and physical service environment quality between robot-delivered services and human-delivered services [35].

Existing restaurant research describes the physical environment, food quality, and service quality as the major dimensions of service quality affecting customer intentions to visit restaurants [36–39]. Along these lines, research in restaurant robots emphasizes three key service pillars of a high-tech atmosphere, food quality, and service quality as critical antecedents of customer patronage intentions toward robotic restaurants [40].

Zhu (2022) determined that a high-tech atmosphere is an important dimension of consumer interest in robotic restaurants and their continuing intention to use [40]. Innovative technology aspects of robot-made foods can enhance consumers' dining experiences [41]. Some consumers expect that food made by robots will be of lower quality than food made by human chefs [8]. Guan et al. (2022) found that servicescapes at robotic restaurants (e.g., decorations, atmosphere, and/or cleanliness) directly affect diners' behavioral intentions to visit [42]. Another previous study [40] found that consumer perceptions toward service quality in robot waiters—when the service is accurate, consistent, prompt, comfortable, and/or friendly—had a positive impact on their intentions to use, and that this influence is mediated by their interest in robotic restaurants.

Finally, this current study pays close attention to human–robot interaction quality in comparison to traditional restaurants where humans serve. Human–robot interaction in this study refers to communication between service robots and consumers, with the aim of resolving consumers' needs [43]. Human–robot interaction is considered a critical factor in a consumer's emotional experience [44], and hotels have been shown to benefit from flexible, exciting, and enjoyable interactions with service robots [45]. Human–robot interaction can improve the service performance of technology, and service robots have emerged as new providers in the hospitality industry [6,44]. Fuentes-Moraleda et al. (2020) investigated the Service Robot Acceptance Model (sRAM) of functional elements, social-emotional elements, and relational elements in hotel tourism [44]. They found that the functionality of a robot most affects the interaction between the robot and the hotel guest. The primary technological purpose in human–robot interaction involves implementation of technology for acceptance by users [46].

Previous research in human–robot interaction has discussed a theoretical framework from the viewpoint of innovative technology acceptance. The human–robot interaction literature has been more extensively explored in relation to anthropomorphic features such as human-like appearance. According to the review paper on human–robot interaction in hospitality and tourism, research on human–robot interaction has not been sufficiently adapted to consider the unique characteristics of the hospitality industry, including intangible, sensitive, and experience-oriented characteristics of the hospitality industry, while many studies have instead examined general application of robotics and AI [47]. From the viewpoint of enhancing service quality, it is required to clarify the interaction between humans and robots in restaurant settings.

In summary, based on the preceding literature, this study assumes four important components in service quality of robotic restaurants: atmosphere quality at high-tech

restaurants, food quality at restaurants with robot chefs, service quality at restaurants where robots provide the service, and interaction quality between service robots and restaurant diners.

2.2. Perceived Value

Perceived value, or the overall subjective evaluation of utility of service between perception of benefits versus costs, is an important concept in understanding customers' behavior in the service industry [48,49]. Causal links between service quality and perceived value have been determined in different industries [50,51]. Keshavarz and Jamshidi (2018) proposed that service quality has a significant and positive effect on perceived value [52]. Many previous studies have determined that service quality affects perceived value within the restaurant business. Tuncer et al. (2021) found that service quality positively affects perceived value in the luxury restaurant industry [53], while Konuk (2019) demonstrated that positively perceived food quality influences diners' perceived value at organic food restaurants [54].

H1. *Atmosphere quality, food quality, service quality, and interaction quality of robotic restaurants collectively influence consumers' perceived value.*

H1a. *Atmosphere quality of robotic restaurants positively influences consumers' perceived value.*

H1b. *Food quality of robotic restaurants positively influences consumers' perceived value.*

H1c. *Service quality of robotic restaurants positively influences consumers' perceived value.*

H1d. *Interaction quality of robotic restaurants positively influences consumers' perceived value.*

2.3. Restaurant Image, Satisfaction, and Revisit Intention

Perceived value and satisfaction are commonly acknowledged as the primary expectations to fulfill for customer dining experiences [55]. The existing literature has provided support for a causal connection between perceived value and satisfaction [56,57], as well as for the idea that consumers' intentions are based on perceived value [57]. Chang and Wildt (1994) found that, as perceived value increases, perceived repurchase intentions increase positively [58]. Additionally, Chen et al. (2020) determined that positive perceived value explains variance in consumers' revisit intentions toward Chinese traditional restaurants [59].

H2. *Perceived value positively influences customer satisfaction.*

H3. *Perceived value positively influences robotic restaurant revisit intention.*

The definition of image can be explained as subjective understanding, attitude, and a blend of conceptual attributes [60] or as a lingering impression in customers' collective mind [61]. In this study, the term "robotic restaurant image" is defined as the collective perceptions, beliefs, ideas, feelings, or attitudes stored in customer memory concerning any given robotic restaurant [62]. Perceived value is associated with image. Wijaya et al. (2020) showed that customer perceived value can affect a positive company's brand image [26]. Also, Barich and Kotler (1991) posited that a company will possess a powerful image when consumers perceive their receipt of high value from their transactions [63]. In the investigation of service in airlines, Ostrowski et al. (1993) asserted that good consumption experience will lead to positive image [64]. Hu et al. (2009) determined the positive impact

of perceived value on hotel image, finding that consumers form a positive image when they believe they perceive excellence from the hotel services provided [25]. Thus, it is logical to presume that a higher perceived value will increase the robotic restaurant image, even though this specific association is scarcely explored in the restaurant literature.

The literature emphasizes the crucial role of image in the establishment of brand equity [65] and states that brand image is a strong marketing tool for differentiation from rivals [66]. Wu (2013) confirmed that the positive image of restaurants with quick service influences customer satisfaction [67]. Also, Dam and Dam (2021) studied supermarket brands to determine the positive influence of brand image on consumer satisfaction [68]. The related hypothesis is as follows:

H4. *Perceived value positively influences robotic restaurant image.*

H5. *Robotic restaurant image positively influences customer satisfaction.*

Review of the existing literature in hospitality confirms that consumer satisfaction affects behavioral intentions [69,70]. In one study on robotic restaurants, Seo and Lee (2021) found that customers who were satisfied with robot-based service showed a positive intention to revisit [71]. Kim et al. (2021) emphasized the important role of customer satisfaction by showing the positive influence of service satisfaction at a robot coffee shop on customers' revisit intention [72]. The latest research conducted by Soliman et al. (2023) demonstrates that satisfaction in domestic Egypt tourists with service robots influenced their intentions to use robot-delivered services [73]. Sufficient evidence from various restaurant research supports the positive influence of satisfaction on behavioral intentions [74,75]. Thus, drawing from the prior literature, the hypotheses are as follows (Figure 1).

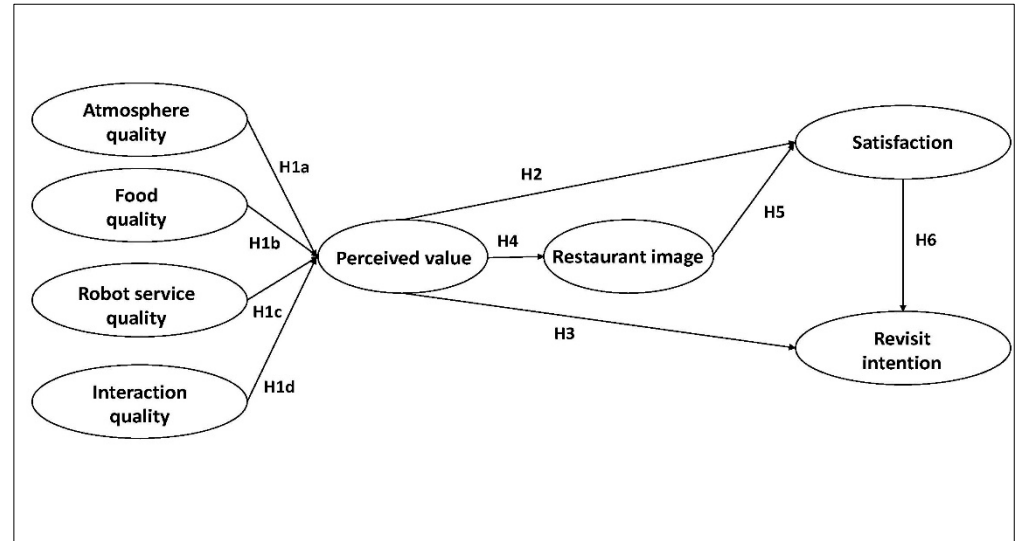


Figure 1. Proposed model.

H6. *Customer satisfaction positively influences robotic restaurant revisit intention.*

3. Methodology

3.1. Measurement

To identify associations in service quality, perceived value, robotic restaurant image, satisfaction, and revisit intentions among customers, a measurement tool was developed. The questionnaire comprises two parts. The first part is composed of respondents' general demographics, including sex, age, level of education, and employment. The second

part of the questionnaire asks about customers' perceived quality (atmosphere quality, food quality, service quality, and interaction quality), perceived value, robotic restaurant image, satisfaction, and revisit intention on a five-point scale (1: strongly disagree to 5: strongly agree).

Study measurements were developed through a review of the literature, and 24 items were utilized for causal relationship analysis (see Table 1). Restaurant service quality was assessed using three items each for atmosphere [62,76], food [62,76], and service [62,77], and two items for interaction [78,79]. These were adapted from previous research, as were the measurement items comprising three items for perceived value [80], three items for robotic restaurant image [81], two items for customer satisfaction [82], and four items for revisit intention [83].

Table 1. Questionnaire.

Constructs	Items	Measures
Atmosphere quality	AQ ₁	The interior design of the robotic restaurant will be visually appealing.
	AQ ₂	The restaurant's inside ambiance will be pleasant.
	AQ ₃	Lighting will create a comfortable atmosphere.
Food quality	FQ ₁	The food served at this robotic restaurant might be delicious.
	FQ ₂	The robotic restaurant will offer a variety of menu items.
	FQ ₃	The robotic restaurant will serve healthy food.
Service quality	SQ ₁	The robotic restaurant will serve food as ordered by the diner.
	SQ ₂	The robotic restaurant will provide consistent service.
	SQ ₃	The robotic restaurant will provide prompt service.
Interaction quality	IQ ₁	Interactions between the robot and diners will be flexible.
	IQ ₂	Interactions between the robot and diners will be reliable.
Perceived value	VA ₁	Robot service at this restaurant will provide better value than expected for the money paid.
	VA ₂	The dining experience at this robotic restaurant is worth the money.
	VA ₃	The robot service at this restaurant provides a good deal in comparison to service at other restaurants.
Restaurant image	RI ₁	The restaurant with robotic services will be innovative.
	RI ₂	The restaurant with robotic services will be creative.
	RI ₃	The restaurant with robotic services will offer new experiences.
Satisfaction	SA ₁	The overall service at this robotic restaurant will be satisfactory.
	SA ₂	Overall, I will be satisfied with my experience at this robotic restaurant.
Revisit intention	RI ₁	I would like to visit this robotic restaurant frequently.
	RI ₂	I try to visit robotic restaurants where robot service is provided.
	RI ₃	I plan to revisit this robotic restaurant in the future.
	RI ₄	I expect to visit this robotic restaurant again soon.

3.2. Data Collection and Analysis

Before evaluating the items developed from previous research, a realistic scenario was presented to describe the environment of a future restaurant. In this scenario, participants were asked to imagine visiting a typical Italian restaurant in Seoul, Korea, where they would experience innovative technologies, receive service from an artificial intelligence robot, and

plan to eat tomato pasta. Participants were shown photos illustrating a chef robot cooking the ordered pasta and a service robot delivering the dish, which were presented along with the scenario (Figure 2). A questionnaire was developed and pilot-tested on 150 people (50 college students and 100 university students). Finally, this survey was conducted online through a web-based professional company targeting a panel of respondents with recent restaurant experiences in Korea.

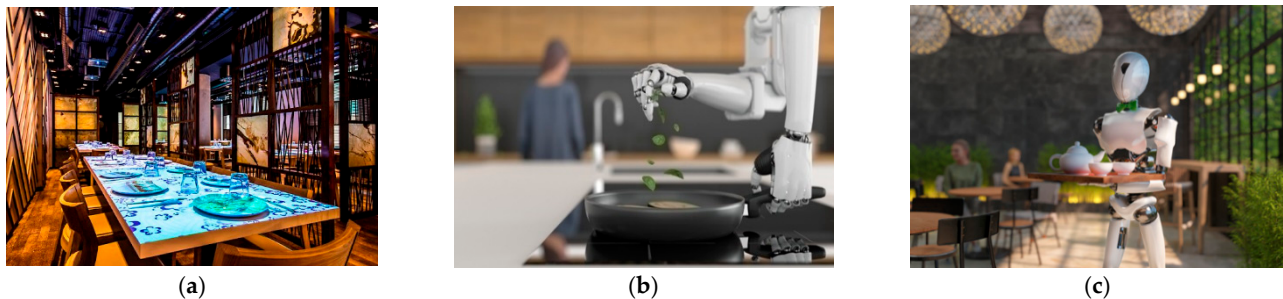


Figure 2. Scenarios: (a) high-tech atmosphere; (b) chef robot; (c) a serving robot (Image source: Pixabay, licensed use).

A total of 364 panelists responded over the course of one month, and missing data and biased responses were deleted. Analysis was based on the data from 342 valid respondents with a response rate of 94.0%. All data were analyzed using Statistical Package for Social Sciences (SPSS, AMOS 21.0) software. The proposed hypotheses were tested and the theoretical model was verified with structural equation modeling (SEM).

4. Results

4.1. Profiles of Study Respondents

Among the respondents, 167 (48.8%) were male, and 175 (51.2%) were female, as shown in Table 2. People in their 20s, 30s, and 40s represented similar proportions of the sample (27.2%, 28.9%, and 29.3%, respectively), and the majority of the participants graduated from university (215, 62.9%). Additionally, a total of 146 respondents (42.7%) indicated that they were officers.

Table 2. Demographic characteristics ($N = 342$).

Factor	Characteristics	<i>n</i>	%
Gender	Male	167	48.8
	Female	175	51.2
Age	20~29	93	27.2
	30~39	99	28.9
	40~49	100	29.3
	50~	50	14.6
Level of education	High School	39	11.4
	College	58	16.9
	University	215	62.9
	Graduate School	28	8.2
	Others	2	0.6
Occupation	Officer	146	42.7
	Professional	31	9.1
	Self-employed	21	6.1

Table 2. Cont.

Factor	Characteristics	<i>n</i>	%
	Public Official	12	3.5
	Housewife	44	12.9
	Production worker	14	4.1
	Student	38	11.1
	Unemployed	16	4.7
	Others	20	5.8

4.2. Study Reliability and Validity

All evaluation items were subjected to reliability analysis and validity verification. Although it is generally recommended that latent variables be measured with at least three indicators to ensure validity and reliability, both interaction and satisfaction were measured with only two items. These constructs demonstrated acceptable psychometric properties: all factor loadings exceeded 0.653, and Cronbach's alpha values were above 0.778. Composite reliability ranged from 0.826 to 0.926 and was higher than the recommended cut-off of 0.70 [84]. Additionally, average variance extracted (AVE) values ranged from 0.552 to 0.765, meeting the recommended standard of 0.50 [85]. The model demonstrated an acceptable fit to the data ($\chi^2/df = 1.497$, GFI = 0.925, NFI = 0.938, CFI = 0.978, RMSEA = 0.038, RMR = 0.027), confirming the convergent validity of the measurement model (Table 3). Discriminant validity was evaluated by comparing AVE values and the squared correlation value of the two potential factors (Table 4). The range of squared correlation values (0.135 to 0.542) of the two latent factors was lower than the lowest value of AVE (Food quality: 0.552); thus, discriminant validity was confirmed.

Table 3. Reliabilities and confirmatory factor analysis.

Construct	Standardized Loadings	<i>t</i> -Value	Composite Reliabilities	AVE	Cronbach's Alpha
Atmosphere quality			0.846	0.570	0.799
AQ ₁	0.724	fixed			
AQ ₂	0.782	12.342 ***			
AQ ₃	0.758	12.101 ***			
Food quality			0.826	0.552	0.778
FQ ₁	0.653	fixed			
FQ ₂	0.778	11.363 ***			
FQ ₃	0.790	11.463 ***			
Service quality			0.895	0.643	0.842
SQ ₁	0.824	fixed			
SQ ₂	0.798	15.334 ***			
SQ ₃	0.784	15.057 ***			
Interaction quality			0.882	0.765	0.864
IQ ₁	0.918	fixed			
IQ ₂	0.829	16.097 ***			
Perceived Value			0.879	0.661	0.849
VA ₁	0.779	fixed			
VA ₂	0.870	16.555 ***			
VA ₃	0.786	14.952 ***			
Restaurant image			0.891	0.649	0.842
IM ₁	0.869	Fixed			
IM ₂	0.816	16.951 ***			
IM ₃	0.726	14.668 ***			

Table 3. Cont.

Construct	Standardized Loadings	t-Value	Composite Reliabilities	AVE	Cronbach's Alpha
Satisfaction			0.910	0.704	0.824
SA ₁	0.859	Fixed			
SA ₂	0.818	17.071 ***			
Revisit intention			0.926	0.717	0.909
RI ₁	0.840	Fixed			
RI ₂	0.889	20.731 ***			
RI ₃	0.869	20.011 ***			
RI ₄	0.785	17.119 ***			

Note: Atmosphere quality (AQ), food quality (FQ), service quality (SQ), interaction quality (IQ), perceived value (VA), robotic restaurant image (IM), satisfaction (SA), revisit intention (RI). $\chi^2 = 302.392$, $df = 202$, $\chi^2/df = 1.497$, goodness of fit index (GFI) = 0.925, normed fit index (NFI) = 0.938, comparative fit index (CFI) = 0.978, root mean square error of approximation (RMSEA) = 0.038; root mean square residual (RMR) = 0.027; *** $p < 0.001$.

Table 4. Discriminant validity and correlations estimates.

	1	2	3	4	5	6	7	8	M ± S.D.
1. AQ	0.570 ^a	0.360 ^b	0.297	0.251	0.234	0.346	0.355	0.212	3.660 ± 0.718 ^c
2. FQ		0.552	0.396	0.353	0.343	0.311	0.430	0.317	3.463 ± 0.744
3. SQ			0.643	0.213	0.135	0.312	0.394	0.135	4.109 ± 0.695
4. IQ				0.765	0.425	0.181	0.309	0.315	3.384 ± 0.871
5. VA					0.661	0.335	0.514	0.517	3.155 ± 0.785
6. IM						0.649	0.207	0.312	3.874 ± 0.724
7. SA							0.704	0.542	3.529 ± 0.629
8. RI								0.717	3.262 ± 0.794

Note: Atmosphere quality (AQ), food quality (FQ), service quality (SQ), interaction quality (IQ), perceived value (VA), restaurant image (IM), satisfaction (SA), revisit intention (RI). ^a Average variance extracted (AVE); ^b matrix entries are the square correlations; ^c mean ± standard deviation.

4.3. Structural Equation Modeling (SEM)

We tested the proposed hypotheses using a structural equation model (SEM). Table 5 presents the standardized path coefficients, t -values, and results of each hypothesis. The total fit of the model was acceptable ($\chi^2/df = 1.928$, GFI = 0.900; NFI = 0.915; CFI = 0.957; RMSEA = 0.052; RMR = 0.048). Among the service quality dimensions, atmosphere quality ($\beta = 0.165$; $t = 2.320$; $p < 0.05$), food quality ($\beta = 0.329$; $t = 3.768$; $p < 0.001$), and interaction quality ($\beta = 0.420$; $t = 6.211$; $p < 0.001$) had significant effects on perceived value. Accordingly, hypotheses 1a, 1b, and 1d were supported. However, hypothesis 1c (regarding the association between service quality and perceived value) was rejected ($\beta = -0.045$; $t = -0.643$; $p > 0.05$). Perceived value was shown to have a significant effect on satisfaction ($\beta = 0.530$; $t = 7.790$; $p < 0.001$), revisit intention ($\beta = 0.463$; $t = 5.527$; $p < 0.001$), and robotic restaurant image ($\beta = 0.623$; $t = 10.013$; $p < 0.001$). Thus, hypotheses 2, 3, and 4 were verified. In stating that robotic restaurant image positively affects satisfaction, hypothesis 5 was supported ($\beta = 0.380$; $t = 5.905$; $p < 0.001$). Hypothesis 6 was supported by the positive relationship shown between satisfaction and revisit intention ($\beta = 0.381$; $t = 4.587$; $p < 0.001$).

Table 5. Results of the structural equation model.

Hypothesized Path (Stated as Alternative Hypothesis)	Standardized Path Coefficients	t-Value	Results
H1a: AQ → VA	0.165	2.320 *	Supported
H1b: FQ → VA	0.329	3.768 ***	Supported
H1c: SQ → VA	−0.045	−0.643	Rejected
H1d: IQ → VA	0.420	6.211 ***	Supported
H2: VA → SA	0.530	7.790 ***	Supported
H3: VA → RI	0.463	5.527 ***	Supported
H4: VA → IM	0.623	10.013 ***	Supported
H5: IM → SA	0.380	5.905 ***	Supported
H6: SA → RI	0.381	4.587 ***	Supported

Note: $\chi^2 = 414.546$; $df = 215$; $\chi^2/df = 1.928$, goodness of fit index (GFI) = 0.900; normed fit index (NFI) = 0.915; comparative fit index (CFI) = 0.957; root mean square error of approximation (RMSEA) = 0.052; root mean square residual (RMR) = 0.048. *** $p < 0.001$, * $p < 0.05$.

5. Conclusions and Implications

5.1. Discussion and Theoretical Implications

The use of robotic services in the restaurant industry is expected to increase operations by solving challenges pertaining to labor costs and inefficient training and by ensuring contactless service in the era of COVID-19 and beyond [86,87]. Limited research has investigated service quality in chef and server robots, even though AI automation services have begun and human–robot interactions are emerging as a critical determinant of novel, fun, and flexible emotional experiences for consumers. This study examined a conceptual framework comprising four dimensions of service quality in robotic restaurants on customers' perceived value and the causal links among perceived value, restaurant image, satisfaction, and revisit intention in customers.

First, customers' perceptions of atmosphere quality, food quality, and interaction quality of robotic restaurants have positive and significant impacts on perceived value, corresponding to previous findings [51,52]. This finding is valuable in its ability to emphasize the important three dimensions of robotic restaurant service quality—namely, constructs including high-tech atmosphere quality, food quality of a robot chef, and interaction quality between robot servers and customers—which are rarely applied in robot restaurant settings. Our conclusions confirm that greater perceived accuracy and flexibility in robots' interactions with restaurant diners lead to higher perceived value of the restaurant. The majority of service quality research, particularly studies focusing on human–robot interaction in robotics, typically involves the exploration of engineering theory based on laboratory experiments [47,88,89]. Exploration of human–robot interactions has not been conducted widely in the existing restaurant literature. Service robots, however, have engaged in direct interactions because (unlike other machines or computers) they are more exposed to humans [35,90]. According to one previous study, positive human–hotel service robot interactions are achieved through strengthened functional elements and relational elements such as security and trust [44]. This research adds to the human–robot interaction literature, which to date is not considered a mature field of study [6]. Contrary to expectations, no significant influence of service quality on perceived value has been found. As pointed out in the previous study [17] on the limitations of robots in hospitality and tourism, it was revealed that service robots lacking a human touch are less effective in restaurant settings where intangible values are emphasized.

Second, findings from this study show that perceived value positively affects robotic restaurant image, indicating that as consumers obtain higher perceived value from dining experiences at robotic restaurants, the robotic restaurant image becomes more favorable.

This conclusion is consistent with findings from previous research [25,26,63]. Results additionally demonstrate the significant influence of perceived value on customers' satisfaction and revisit intentions at robotic restaurants. This finding enhances our understanding of the restaurant field by offering insights into brand image in the context of robotic restaurants. Despite one recent study by Hwang et al. (2020 & 2021) examining the relationship between imagery and motivation, few empirical studies have been conducted on how restaurant image is formed or on which antecedent variables influence restaurant image [85,91]. This study distinguishes itself as one of the few that empirically examines the significant correlation between perceived value and robotic restaurant image.

Third, our findings determine that levels of consumer satisfaction and revisit intentions are increased by favorable perceived value. This result is consistent with the results of research by Gallarza et al. (2011) and Thielemann et al. (2018) [56,57], indicating that perceived value positively affects consumer satisfaction and consequently influences consumer behavior. This study yields a framework to better understand how perceived value is regarded as an important variable to predict consumers' satisfaction and intentions to revisit robotic restaurants, similar to findings demonstrated in other empirical studies in traditional restaurants [38,58,59].

Fourth, our findings confirm that an enhanced robotic restaurant image leads to consumers' positive satisfaction and revisit intentions. This means that when consumers have a positive image about robotic restaurants, they are more inclined to be satisfied and to show higher intentions to visit. Previous empirical research supports the findings of this study [72,92]. Because perceived value and image of robotic restaurants positively influence robotic restaurant diners' decision-making processes, efforts to improve these dimensions are necessary to boost performance, market share, competitive advantage, and many other metrics of robotic restaurants' wellbeing. This study broadens the literature in applied robotics by suggesting a noteworthy conceptual framework for robotic restaurants.

5.2. Managerial Implications

Robots, artificial intelligence, and service automation (RAISA) in the service industry not only provide benefits, such as cost savings and improved employee productivity [5], but also enhance consumers' perceptions of service quality by providing attractive service delivery, communicating, and creating value in dimensions of fun and entertainment [93]. Thus, it is expected that adoption of service automation will increase. As demand for robot service increases, proposing strategies to apply in the restaurant industry is meaningful. First, robotic restaurant managers should plan marketing promotions that differentiate and create uniqueness in atmosphere, quality of food, and quality of interaction to enhance customers' perceived value and satisfaction with dining experiences in ways that are sufficient to retain customers and instill loyalty.

For example, robotic chefs in open kitchens can be used in restaurant advertisements as a novel tactic to improve service quality. In addition, restaurant managers should try to adopt robotic servers that perform well in terms of interactions with consumers to improve interaction quality. Second, restaurateurs should endeavor to create a favorable image for robotic restaurants through advertising that emphasizes new and cutting-edge dining experiences for customers. Third, when refining the features of robot servers, it is crucial for the industry to consider the benefits and costs of design.

5.3. Conclusions

This study's findings confirm the impact of three dimensions of service quality, i.e., high-tech atmosphere quality, food quality, and interaction quality, on perceived value among customers in robotic restaurant settings. Also, this study demonstrates that as

the impact of service quality on perceived value increases, satisfaction levels rise along with customers' intentions to revisit. Indeed, image is shown to have a positive impact on satisfaction and revisit intention in customers. This study contributes to the existing literature in two aspects. First, it enriches the existing robotic restaurant literature by suggesting new perspectives on the antecedent variables of consumers' satisfaction and revisit intentions toward service robot restaurants. Second, it is the first study to propose a conceptual model explaining the interrelationships of service quality, perceived value, image, and intention to revisit within the setting of service robot restaurants.

This study is distinguished from existing research by providing the implication that robot services are expected to offer novel service experiences, rather than merely cooking or delivering food. Furthermore, it contributes to the robotic restaurant literature by emphasizing the importance of restaurant image, considering the paucity of existing studies in this context.

6. Limitations and Future Research

While this study makes significant contributions to the existing literature, it also encompasses several issues to be addressed in further research. First, this research uses a scenario-based survey, but real robot service and actual food quality assessments following real experiences are recommended for future research. Second, a robot chef with a humanoid arm was used in the scenario, but it would be useful to research the fuller anthropomorphism of a robot chef in consideration of Mori's uncanny valley effect. Third, future research should take into consideration moderating variables such as perceived risk of robot service or generation to increase superior comprehension of the overall effects. Fourth, human–robot interaction has been explored in the dimensions of flexibility and reliability; these are broad dimensions which should be considered in future research. Finally, a small sample size, especially among Korean respondents, can result in a lack of generalizability. Accordingly, consideration should be given in future research to larger samples of respondents from more diverse cultural backgrounds.

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