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THE ROBOTIC SERVER PARADOX: UNPACKING THE MEDIATING ROLES OF NOVELTY AND PERCEIVED EFFICIENCY ON CUSTOMER SATISFACTION IN SAUDI RESTAURANTS AND EWOM

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Abstract: Integrating robotic servers in Saudi Arabia's rapidly evolving hospitality sector presents a paradoxical challenge: while robotic assistance enhances operational efficiency and adds experiential novelty, its impact on customer satisfaction and electronic word-of-mouth (eWOM) remains complex and underexplored. Anchored in the Stimulus-Organism-Response (S-O-R), Expectation Confirmation Theory (ECT), and Technology Acceptance Model (TAM) framework, this study investigates the mediating impact of perceived novelty (PN) and perceived efficiency (PE) on the relationship between the use of robotic assistance (URA) and customer satisfaction (CS), subsequently influencing eWOM. Additionally, it examines the moderating role of service context (SC) on the satisfaction-eWOM linkage within Saudi cultural settings. Data were collected from 348 restaurant customers across Jeddah, Riyadh, and Madinah who experienced robotic service encounters and analyzed using partial least squares structural equation modeling (PLS-SEM). The findings confirm that URA significantly enhances both PN and PE, with efficiency showing a stronger mediating effect on customer outcomes. Service context significantly moderates the CS-eWOM relationship, highlighting the importance of cultural and environmental factors. The results provide actionable insights for restaurant managers to deploy robotic assistance strategically by balancing technological functionality with cu lturally resonant service design, optimizing customer satisfaction and fostering positive electronic advocacy in the Saudi Arabian hospitality market. The study distinguishes the experiential appeal of robotic novelty from the functional contribution of service efficiency and examines their sequential indirect associations with electronic word-of-mouth through satisfaction. The analysis focuses on restaurant customers with first-hand experience with robotic service in three Saudi cities, allowing the model to be examined in an emerging, technology-enabled dining context. By assessing these pathways alongside the conditional role of service context, the study clarifies how customer evaluations of robotic assistance relate to post-encounter communication.

Keywords: Robotic server paradox, perceived efficiency, perceived novelty, customer satisfaction, eWOM

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INTRODUCTION

Robotic servers in the restaurant industry exemplify a revolutionary technological development that substantially changes conventional service models (McCartney & McCartney, 2020; Rosenblatt et al., 2020; Seyitoğlu & Ivanov, 2022). This development is particularly interesting in Saudi Arabia's hospitality industry, where technological change is rapid, and service expectations are unique (Al-Adaileh & Al-Atawi, 2011). The use of robotic assistance not only seeks to increase the level of efficiency in operations by addressing the issue of labor shortages and service errors, but it also seeks to add a level of novelty

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to the customer experience, thus determining the level of satisfaction and the resulting behaviour, such as eWOM (Hwang et al., 2021; Xie et al., 2022). In spite of the above-stated advantages, the phenomenon of the Robotic Server Paradox manifests, which results in the perceived efficiency and novelty of service being enhanced through the presence of the robotic server; yet at the same time, the customer may react favorably or unfavorably, which affects the customer's satisfaction level along with the dissemination of eWOM, as suggested in the study by Tilson et al. (2012).

Restaurant operators in Saudi Arabia must understand the Robotic Server Paradox to strategically introduce robotic servers in ways that align with the country's cultural context (Al-Adaileh & Al-Atawi, 2011). This study further (Figure 1) examines the role of PN and PE as mediators in CS and their role in eWOM in Saudi Arabia's restaurant industry, as per El-Said & Al Hajri (2022). It also examines how SC, which comprises Saudi Arabia's unique cultural and environmental characteristics, moderates the relationship between satisfaction and eWOM (Ma et al., 2023; Oh & Parks, 1996). The goal is to provide recommendations to improve the use of robotic assistance, customer experiences, and positive electronic word-of-mouth in the region's hospitality industry (Mariani & Baggio, 2022; Shah et al., 2023).

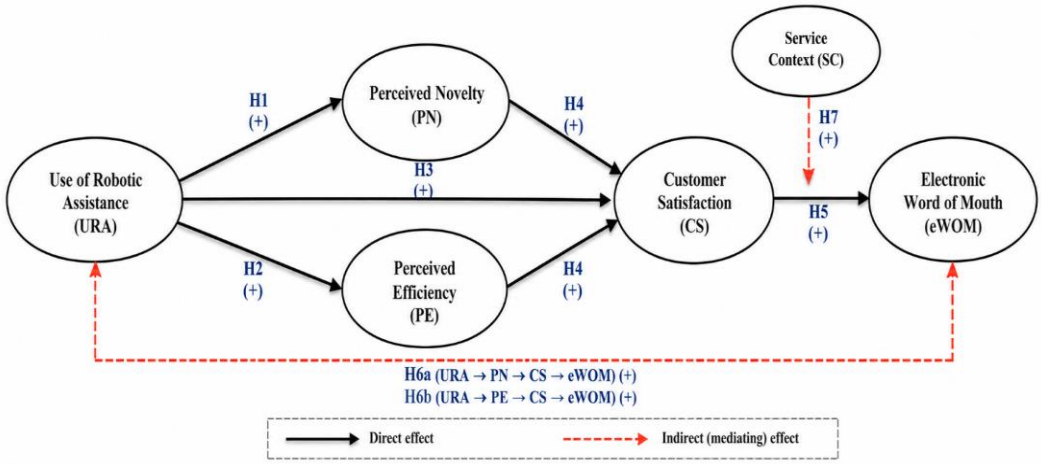


Figure 1. Theoretical framework

REVIEW OF LITERATURE & HYPOTHESES DEVELOPMENT

Theoretical underpinnings

Research on the Robotic Server Paradox draws on three foundational theories: the Technology Acceptance Model (TAM), Expectation Confirmation Theory (ECT), and the Stimulus-Organism-Response (S-O-R) model (Dhiman & Jamwal, 2023; Koul & Eydgahi, 2017; Oliver, 2010). Together, these frameworks explain the adoption of robotic assistance, customer satisfaction, and post-experience behavioral consequences such as EWOM. These concepts provide a solid basis for understanding the complex interplay between technological innovation and human perception in a service setting.

The Technology Acceptance Model (TAM) is a primary conceptual model for interpreting customers' acceptance of robotic services (Davis, 1989; Kao & Huang, 2023; Lee et al., 2018). TAM suggests that an individual's behavioral intention to use a particular technology is influenced by perceived usefulness and perceived ease of use (Davis, 1989). In this study, perceived efficiency is used synonymously with perceived usefulness, where customers rate the robot's ability to provide speedy services (Jain & Gupta, 2004; Yam et al., 2021). Likewise, perceived novelty may also lead to perceived ease of use or a positive attitude toward the system, since a novel and exciting experience could motivate customers to engage with the system (Shams et al., 2015; Xie et al., 2022). Studies on service robots in the hospitality industry, such as in hotels and restaurants, have also validated the predictive power of TAM in determining the customer's attitude towards service robots (Kao & Huang, 2023; Lee et al., 2018; Zhong et al., 2021). ECT explains customer post-adoption satisfaction and continuance behavior by positing that customer satisfaction depends on whether the customer's experience meets or exceeds their expectations. According to the theory, customer satisfaction depends on whether the customer's experience meets or exceeds their expectations. Therefore, the customer's experience, compared with their expectations, determines their level of satisfaction. If the customer's experience exceeds their expectations, they will be highly satisfied. If the customer's experience is the same as their expectation, they will have (Kivela et al., 1999). High satisfaction, especially when customers' expectations are exceeded, plays a significant role in shaping continuance intentions and positive behaviors such as eWOM (Adwan et al., 2020; Rasheed & Abadi, 2014; Ruiz-Alba et al., 2022). From the perspective of robotic servers, ECT is supported, as satisfaction results from customers verifying expectations related to the server's efficiency, novelty, and overall experience, prompting them to share positive online reviews (Hussain, 2016; Tam, 2004).

The S-O-R model provides a holistic behavioral framework by focusing on how stimuli affect the organism's internal state, which in turn shapes behavioral responses (Tung & Au, 2018). In this study, the stimuli are URA, which results in the internal cognitive and emotional "organismic" states of the customers, specifically PN and PE (Song et al., 2019). These are the internal states that facilitate the effect of service robotics on subsequent behavioral outcomes, which include CS and eWOM, as proposed in the study of (Song et al., 2019). Overall, the S-O-R model illustrates the complex cognitive and emotional processes in the customer service context regarding service innovation, providing a holistic view of how different elements of robotic service affect customer experiences and behaviors (Tung & Au, 2018).

Influence of use of robotic assistance (URA)

Robot assistance introduces new and innovative forms of service interaction in hospitality environments, such as restaurant settings, where customers perceive the experience as new and exciting (Xie et al., 2022). Incorporating robots into a service environment inherently offers customers a new and unique element of attention (Tokunaga, 2013; Xie et al., 2022). In the context of the robotic restaurant environment, research has shown that technology innovations, especially in the forms of anthropomorphic and intelligent robot behaviors, contribute to the perception of novelty for the customer (Jansson, 2011; Shams et al., 2015; Xie et al., 2022). This perception of novelty is important for initial technology adoption and for building interest in the service (Tokunaga, 2013). Therefore,

H1: URA has a positive effect on PN.

By definition, robotic assistance improves performance because it delivers services faster, more precisely, and more reliably (Jain & Gupta, 2004). Studies have consistently shown that service robots can improve service quality, which customers perceive as greater efficiency (Hwang et al., 2021; Yam et al., 2021). In a restaurant setting, robotic servers could complete tasks such as order-taking and food delivery more efficiently, thereby improving customers' evaluation of the service's effectiveness and efficiency (Hwang et al., 2021). Customers tend to compare robotic servers' efficiency with that of human servers; in most cases, robotic servers deliver service more efficiently (Jain & Gupta, 2004). Thus,

H2: URA has a positive effect on PE.

Incorporating robotic assistance offers distinctive, efficient service experiences that may play an essential role in fulfilling customers' needs and expectations(Shah et al., 2023; Slack & Singh, 2020). Empirical research suggests that customer satisfaction is positively related to perceptions of robotic services as novel and efficient, as these factors are associated with a more positive overall service experience (El-Said & Al Hajri, 2022; Mariani & Baggio, 2022). Novelty can create excitement, while efficiency ensures the service is delivered effectively, both of which drive satisfaction in the hospitality industry (Forozia et al., 2013; Seo, 2022). In this way, URA will enhance CS by improving the quality of the dining experience (Shah et al., 2023; Slack & Singh, 2020). Therefore,

H3: URA has a positive effect on CS.

Robotic services improve the customer experience, generating positive responses that, in turn, motivate customers to post positive reviews online (Luo et al., 2021; Mukhopadhyay et al., 2023). The unique nature of interacting with robotic servers can spark conversation, leading customers to share their experiences on social media and review platforms (Lee & Youn, 2009; Verma & Yadav, 2021). Studies show that encounters with robotic servers increase customers' willingness to spread eWOM, reflecting the link between novel service delivery and enhanced communicative behavior (Luo et al., 2021; Mukhopadhyay et al., 2023). This also reflects a broader shift from physical to digital communication, where unique experiences are readily shared (Verma & Yadav, 2021). Therefore,

H4: URA has a positive effect on eWOM.

Influence of customer satisfaction (CS) on electronic word of mouth (eWOM)

Satisfied customers are highly motivated to contribute to eWOM, sharing positive experiences across online platforms (Adwan et al., 2020; Rasheed & Abadi, 2014; Ruiz-Alba et al., 2022; Serra-Cantallops et al., 2020). The literature consistently shows that satisfaction is a critical motivator in eWOM, as customer satisfaction is directly linked to recommendations and online reviews (Lee & Youn, 2009; Pourfakhimi et al., 2020; Verma & Yadav, 2021). In the hospitality industry, customer satisfaction is particularly salient in promoting eWOM because experiences are central (Akdim, 2021; Serra-Cantallops et al., 2020). Thus,

H5: CS has a positive effect on eWOM.

Perceived novelty (PN) and perceived efficiency (PE) as mediators

The novelty of perceived robotic assistance rejuvenates customer engagement and experience, thus mediating URA's impact on customer satisfaction (Tokunaga, 2013; Wu et al., 2021; Xie et al., 2022). The novelty of the robotic experience drives customer satisfaction, as newness brings customers joy (Dai et al., 2015; Jansson, 2011). This novelty-driven satisfaction, in turn, will generate higher levels of eWOM, as customers are motivated to share their unique experiences (Al-Hawari & Ward, 2006; Hussain, 2016). Although novelty can stimulate customer engagement, this effect may be short-lived, suggesting that novelty must be sustained over time to maintain customer engagement and satisfaction (Wu et al., 2021; Xie et al., 2022). Thus,

H6a: PN mediates the relationship between URA and CS, enhancing eWOM.

The perceived efficiency generated by the robot's service quality serves as a key mechanism through which URA enhances customer satisfaction (Hwang et al., 2021; Jain & Gupta, 2004; Khalifa et al., 2025). As long as the customers receive efficient service from the robot, their basic service expectations are satisfied, which enhances their satisfaction (Al-Hawari & Ward, 2006; Teas, 1993a). This enhanced satisfaction, resulting from efficient service delivery, then contributes to positive Finally, the significance of eWOM emphasizes the PE's mediating role in the link between robot support and customer advocacy, as suggested by Hapsari et al. (2020) and Kaura et al. (2015). Predictable robot service can also build customer trust, which in turn increases customer satisfaction and advocacy (Giunta et al., 2010; Teas, 1993a). Thus,

H6b: PE mediates the relationship between URA and CS, to enhance eWOM.

Service context (SC) as a moderator

Service context, which includes environmental, cultural, and situational factors like those in a restaurant in Saudi

Arabia, is also a determinant of the way in which customer satisfaction is transferred to eWOM, as per the studies by Horng et al. (2018), Li & Huang (2017), and Oh & Parks (1996). In Saudi Arabia, cultural factors such as collectivism, the importance of social connections, and hospitality are also likely to affect customers' willingness to engage in eWOM, even when they are satisfied (Al-Adaileh & Al-Atawi, 2011; Rizomyliotis et al., 2021). For example, sharing a positive experience may vary by community culture, such as whether to share a compliment or keep it private. The physical environment, such as the restaurant's ambiance, and customer demographics may also influence the strength of the relationship between CS and eWOM (Lai, 2015; Qin & Prybutok, 2009). Therefore, the service environment may enhance or reduce the transfer of customer satisfaction into positive online word-of-mouth across hospitality settings (Ma et al., 2023; Oh & Parks, 1996; Ruiz-Alba et al., 2022). Therefore,

H7: SC moderates the relationship between CS and eWOM.

METHODOLOGY

Sampling procedure

To identify the target population, the research focused on restaurant patrons in Saudi Arabia who received assistance from robots during their restaurant interactions. The research targeted metropolitan cities such as Riyadh, Jeddah, and Madinah, which are major technological hubs in Saudi Arabia's hospitality sector. The study used purposive sampling to select restaurants that incorporated robotic servers into their service delivery. The study's key population consisted of diners aged 18 and above who had experienced full service with the aid of a robot. We selected participants based on their direct experience with robotic service encounters, allowing them to provide meaningful assessments of perceived novelty, efficiency, satisfaction, and electronic word-of-mouth intentions, the main themes of this study.

The data were collected between November 2025 and January 2026 using a structured questionnaire administered in person at the restaurant and online, depending on respondents' accessibility and preference. The study distributed 500 questionnaires across selected restaurants in the three metropolitan areas. With follow-ups and assistance from restaurant managerial staff, the study collected 383 responses. After data cleaning, the final analysis included 348 valid responses, equating to a response rate of 69.6%. All the respondents participated voluntarily, and their consent was obtained.

The study strictly adhered to ethical principles of anonymity and confidentiality throughout the process. The questionnaire was translated into Arabic and English to suit respondents' language preferences, given the multicultural nature of restaurant-goers in Saudi Arabia's major cities. Bilingual researchers were on standby in case the respondents needed further clarification on the measurement items to ensure understanding.

The Saudi Arabian restaurant industry was chosen because the Kingdom's Vision 2030 program has accelerated the adoption of cutting-edge technologies, including robots, in the service industry. This setting provides an appropriate backdrop for examining the Robotic Server Paradox, especially how novelty and efficiency mediate customer responses to robotic assistance, which vary by culture and service context. However, the findings may be unique to the Saudi Arabian context; therefore, other studies should replicate them in other settings.

The sample size of 348 was evaluated for sufficiency for Partial Least Squares Structural Equation Modeling (PLS-SEM). A common heuristic for minimum sample size in PLS-SEM is the '10-times rule' (Elnagar et al., 2026a; Hair et al., 2019; Herzallah et al., 2026; Salama & Elnagar, 2026). It is critical to note that this rule refers to the larger of two criteria: (1) ten times the largest number of formative indicators for any single construct, or (2) ten times the largest number of structural paths directed at any latent variable in the structural model. This study uses reflective indicators, so the first criterion is not applicable (Ahmed et al., 2025; Verdejo, et al., 2026; Hair et al., 2021; Iriqat et al., 2026; Zaki & Elnagar, 2025). We must apply the second criterion. In the proposed structural model (Figure 1), the construct Customer Satisfaction (CS) is predicted by three paths (from URA, PN, PE, and eWOM) is predicted by three paths (from URA, CS, and the interaction term SC x CS). Therefore, the maximum number of paths pointing at any construct is three. Applying the 10-times rule yields an absolute minimum sample size of 10 * 3 = 30. While the sample of 348 is vastly larger than this heuristic minimum, a more robust approach is a power analysis. Using G*Power software (Faul et al., 2009) for a linear multiple regression test with three predictors, an effect size f^2 of 0.15 (medium), an alpha of 0.05, and a power of 0.80, the recommended minimum sample size is 77. Our final sample of 348 far exceeds this requirement, providing strong assurance of the statistical power for the PLS-SEM analysis conducted in this study.

The demographic profile of the 348 respondents showed that the majority (57.8%) were male, while 42.2% were female, indicating a relatively balanced gender distribution among restaurant patrons in the establishments surveyed. In terms of the age distribution of the respondents, the majority 48.3%, were between the ages of 26 and 35, followed by those between the ages of 36 and 45, accounting for 27.6%, and those 25 years old or below, accounting for 16.1%, indicating a young to middle-aged customer segment, which is also the profile of the early adopters of technology. In terms of education, 41.4% had completed a bachelor's degree, 28.7% had postgraduate qualifications, and 23.6% had completed a diploma or high school education, indicating they were well educated and thus equipped to assess their technology service encounters. In terms of frequency, 44.8% dined out 2-3 times a month, 31.6% dined out once a week, and 23.6% dined out occasionally, suggesting they had enough experience to assess their service encounters between robots and humans.

Measurement items

Based on the literature review, the study adopted and modified existing scales to fit the study's conceptual framework and objectives related to the use of robotic servers in Saudi Arabian restaurants. The "Use of Robotic

Assistance (URA)" scale was modified from (Chatterjee, 2020; Seyitoğlu & Ivanov, 2022; Shah et al., 2023; Zhong et al., 2021), which measures the direct exposure of the customer to the use of robotic servers during their meal service. The construct was measured using five items (URA1 to URA5). Perceived Efficiency (PE) was measured using four items (PE1 to PE4) adapted from (Baig et al., 2019; Jain & Gupta, 2004; Teas, 1993b; Yam et al., 2021). Perceived Novelty (PN) construct was based on five items (PN1 to PN5) adapted from (Jansson, 2011; Maddi, 2004; Shams et al., 2015). Service Context (SC) was based on four items (SC1 to SC4) adapted from (Al-Adaileh & Al-Atawi, 2011; Li & Huang, 2017; Oh & Parks, 1996). Customer Satisfaction (CS) was collected using five items labelled CS1 to CS5, adapted from (Khalifa et al., 2025; Pizam et al., 2016; Ruiz-Alba et al., 2022; Singh, 2001). Finally, Electronic Word of Mouth (eWOM) was collected using seven items labelled eWOM1 to eWOM7, adapted from (Akdim, 2021; Mukhopadhyay et al., 2023; Verma & Yadav, 2021). All survey questions were measured using a 5-point Likert scale with a range of 1 ("Strongly Disagree") to 5 ("Strongly Agree"). Pre-testing involved 15 subject matter experts and 20 restaurant customers from the target population. The survey instrument showed strong content validity and internal consistency, as indicated by the measurement model results, including Cronbach's alpha and confirmatory factor analysis.

RESULTS

Measurement model analysis

The measurement model was also evaluated using SmartPLS 4.0, where we examined factor loadings, Cronbach's alpha, composite reliability, and average variance extracted. As shown in Table 1, the constructs showed satisfactory reliability, with Cronbach's alpha and composite reliability above 0.70 and average variance extracted above 0.50. (Herzallah et al., 2025; Henseler et al., 2015; Hair et al., 2019).

URA exhibited α of 0.820, CR of 0.871, and AVE of 0.581, with loadings from 0.807 to 1.000. PE showed α of 0.834, CR of 0.890, and AVE of 0.670, with loadings from 0.688 to 0.779. PN displayed the highest reliability (α=0.906, CR=0.931, AVE=0.729), with loadings from 0.756 to 0.879. SC demonstrated excellent reliability (α=0.898, CR=0.929, AVE=0.766), with loadings from 0.734 to 0.892. CS exhibited outstanding reliability (α=0.920, CR=0.941, AVE=0.765), with loadings from 0.691 to 0.927. eWOM showed good reliability (α=0.887, CR=0.913, AVE=0.600), with loadings from 0.569 to 0.902. Most VIF values were below 5.0, indicating no serious multicollinearity concerns. Thus, the measurement model demonstrated satisfactory psychometric properties for structural analysis.

Table 1. Construct reliability and validity (n=348) Notes: All factor loadings were standardized and were significant at the 0.001 level; AVE = average variance extracted; CR = composite reliability; α = Cronbach's alpha, VIF = variance inflation factor,

Construct	Item	Mean	Std.	Factor Loading	VIF	α, CR, AVE
Use of Robotic Assistance (URA)	URA1: I experienced robotic assistance during my service encounter	4.195	0.841	0.864	1.444	0.820, 0.871, 0.581
	URA2: The service was provided by a robot	4.255	0.812	0.897	1.761	
	URA3: A robot was involved in serving me	4.154	0.800	0.807	1.740	
	URA4: I interacted with a robot during my visit	4.336	0.782	1.000	6.056	
	URA5: Robots were used to deliver services	4.336	0.747	0.892	5.802	
Perceived Efficiency (PE)	PE1: The robot was accurate in its tasks	4.356	0.786	0.731	2.014	0.834, 0.890, 0.670
	PE2: The service delivered by the robot was consistent	4.369	0.689	0.779	2.563	
	PE3: My service needs were efficiently fulfilled by the robot	4.356	0.760	0.707	2.011	
	PE4: The robotic service was effective	4.282	0.733	0.688	1.495	
Perceived Novelty (PN)	PN1: The robotic service felt new and exciting	4.309	0.713	0.863	2.101	0.906, 0.931, 0.729
	PN2: This was a unique service experience compared to traditional methods	4.248	0.741	0.879	3.268	
	PN3: The use of robots in the restaurant was innovative	4.101	0.775	0.756	2.809	
	PN4: I found the robotic server to be novel	4.309	0.874	0.817	3.392	
	PN5: The robotic service provided a fresh experience	4.235	0.718	0.878	2.307	
Service Context (SC)	SC1: The atmosphere of the restaurant contributed to my dining experience	4.242	0.692	0.840	3.900	0.898, 0.929, 0.766
	SC2: The cultural setting of the restaurant influenced my perception of service	4.282	0.705	0.734	4.126	
	SC3: The design and décor of the restaurant enhanced the service	4.188	0.745	0.804	2.336	
	SC4: The overall environment of the restaurant impacted my satisfaction	4.329	0.781	0.892	1.910	
Customer Satisfaction (CS)	CS1: I am satisfied with my overall service experience	4.309	0.802	0.901	4.517	0.920, 0.941, 0.765
	CS2: My dining experience met my expectations	4.255	0.804	0.911	0.000	
	CS3: I am pleased with the service I received	4.262	0.781	0.927	0.000	
	CS4: The service was exactly what I wanted	4.315	0.769	0.919	0.000	
	CS5: Overall, I am happy with the restaurant's service	4.134	0.841	0.691	0.000	
Electronic Word of Mouth (eWOM)	WOM1: I would share my positive experience with the robotic service online	4.174	0.783	0.902	0.000	0.887, 0.913, 0.600
	eWOM2: I am likely to recommend this restaurant to others through social media	4.148	0.830	0.870	3.212	
	eWOM3: I will speak positively about this restaurant to my friends and family online	4.295	0.807	0.834	1.772	
	eWOM4: I would post reviews about my experience with the robotic server	4.128	0.813	0.569	1.841	
	eWOM5: I would encourage others to visit this restaurant after my experience with the robotic server	4.329	0.772	0.722	11.390	
	eWOM6: I will spread positive information about this restaurant on the internet	4.295	0.807	0.718	12.960	
	eWOM7: I will tell other people good things about this restaurant online	4.416	0.787	0.888	2.607	

Table 2. Discriminant validity

Fornell & HTMT	CS	PE	PN	SC	URA	eWOM
CS	0.875	0.728	0.717	0.776	0.675	0.704
PE	0.829	0.819	0.754	0.742	0.791	0.652
PN	0.780	0.868	0.854	0.880	0.767	0.672
SC	0.842	0.859	0.978	0.875	0.668	0.656
URA	0.748	0.903	0.860	0.753	0.762	0.652
eWOM	0.783	0.758	0.749	0.727	0.740	0.775

We assessed discriminant validity using both the Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT). According to Fornell & Larcker (1981), discriminant validity is established when the square root of each construct's AVE exceeds its correlations with other constructs. The results supported this condition, as all diagonal values (square roots of AVEs) exceeded the inter-construct correlations.

Additionally, HTMT values for all construct pairs were below the conservative threshold of 0.85 (Henseler et al., 2015; Zaki et al., 2025), further confirming the constructs' distinctiveness. Together, these findings (Table 2) demonstrate that the measurement model adequately established discriminant validity.

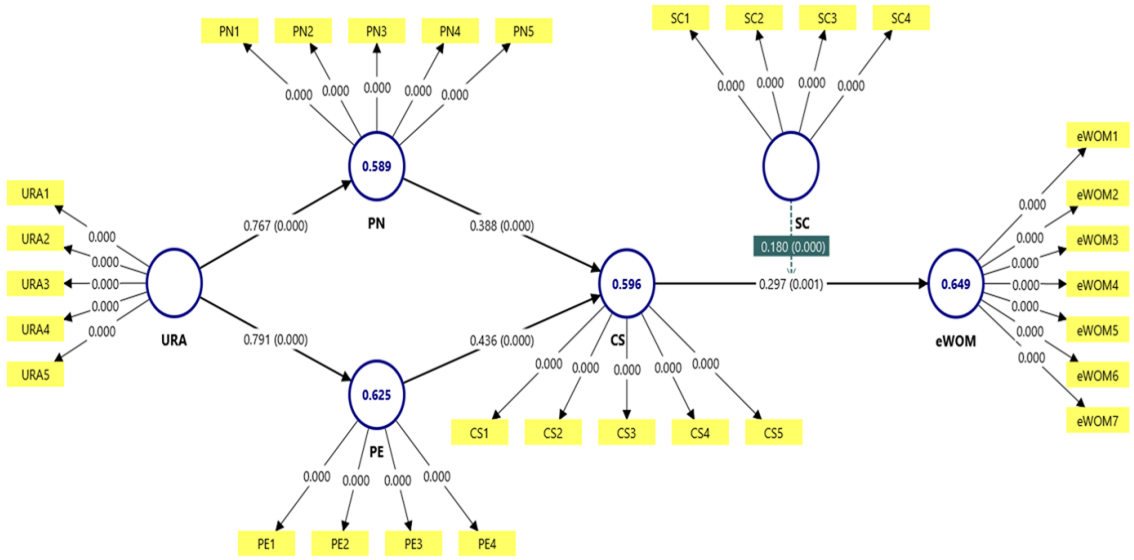


Figure 2. Measurement model diagram Notes: Use of Robotic Assistance (URA), Electronic Word-of-Mouth (eWOM), Perceived Novelty (PN), Perceived Efficiency (PE), Customer Satisfaction (CS), Service Context (SC)

Structural Model Analysis

The structural model was assessed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS version 4. The model's explanatory power was evaluated using the R-squared (R^2) value. The results showed substantial variance explained in the endogenous constructs: eWOM ($R^2 = 0.649$), PE ($R^2 = 0.625$), CS ($R^2 = 0.596$), and PN ($R^2 = 0.589$). These values indicate that the model explains 64.9% of the variance in eWOM, 62.5% in PE, 59.6% in CS, and 58.9% in PN, which are considered moderate to high according to thresholds suggested by Hair et al. (2019). Additionally, the Q^2 values for all endogenous constructs were positive (PN = 0.453, PE = 0.592, CS = 0.629, eWOM = 0.540), confirming the model's predictive relevance.

Table 3. Results of the structural model Note. **P<0.001

H	Relationship	β	SD	T-values	P-values	R^2	F^2	Q^2	Supported?
Direct paths									
H1	URA -> PN	0.767	0.075	10.291	0.000	0.589	1.431	0.453	Yes
H2	URA -> PE	0.791	0.064	12.445	0.000	0.625	1.670	0.592	Yes
H3	URA -> CS	0.643	0.098	6.584	0.000	0.596	—	0.629	Yes
H4	URA -> eWOM	0.191	0.068	2.795	0.003	0.649	—	0.540	Yes
H5	CS -> eWOM	0.297	0.093	3.185	0.001		0.089	0.540	Yes
Indirect paths									
H6a	URA -> PN -> CS -> eWOM	0.088	0.038	2.353	0.010				Yes
H6b	URA -> PE -> CS -> eWOM	0.102	0.040	2.537	0.006				Yes
H7	SC x CS -> eWOM	0.180	0.031	5.868	0.000				Yes

Table 3 shows the direct path results. All proposed relationships (H1-H5) were significant at $p < .01$, providing strong support for the model. Specifically, the strongest relationship was between URA and PE ($\beta = 0.791$, $t = 12.445$, $p < .001$), and

the second strongest was between URA and PN ($\beta = 0.767$, $t = 10.291$, $p < .001$). URA also had a significant positive effect on CS ($\beta = 0.643$, $t = 6.584$, $p < .001$) and eWOM ($\beta = 0.191$, $t = 2.795$, $p = 0.003$). In addition, CS had a significant positive effect on eWOM ($\beta = 0.297$, $t = 3.185$, $p = 0.001$), which proved H5. To examine whether PN and PE mediate the relationship between URA and CS, which leads to eWOM, we conducted a mediation analysis. As shown in Table 3, both indirect effects were significant. The indirect path through PN (URA → PN → CS → eWOM) was significant ($\beta = 0.088$, $t = 2.353$, $p = 0.010$), supporting H6a. Similarly, the indirect path through PE (URA → PE → CS → eWOM) was significant ($\beta = 0.102$, $t = 2.537$, $p = 0.006$), supporting H6b. These findings confirm PN's and PE's mediating roles in the relationship between robotic assistance and customer outcomes. The moderation analysis found that SC significantly moderates the link between CS and eWOM ($\beta = 0.180$, $t = 5.868$, $p < 0.001$), supporting H7. This suggests that the strength of the satisfaction-eWOM relationship depends on service-context characteristics, including cultural and environmental factors relevant to Saudi restaurants. The effect sizes (f^2) varied, ranging from small to large, with URA having a large effect on PN ($f^2 = 1.431$) and PE ($f^2 = 1.670$), whereas CS had a small effect on eWOM ($f^2 = 0.089$).

DISCUSSION AND IMPLICATIONS

This study aims to resolve the Robotic Server Paradox by exploring the relationship between URA, CS, and eWOM, with PN and PE mediating the effect and SC moderating it, in Saudi Arabian restaurants. The results fully supported the proposed theoretical framework, with all seven hypotheses confirmed, providing useful insights into the intricate dynamics of robot service encounters in Saudi Arabia's hospitality industry.

The results show that URA has strong positive effects on PN and PE (H1 and H2), thus validating the idea that robotic assistance inherently evokes customer perceptions of novelty and efficiency. The results align with prior research indicating that technological innovations in services attract customers' attention and encourage involvement because of their novelty (Tokunaga, 2013; Xie et al., 2022). The stronger effect of URA on PE ($\beta = 0.791$), compared with the effect of PN on PE ($\beta = 0.767$), also suggests that customers in Saudi Arabia may place greater importance on functional service quality attributes than on experiential novelty when assessing the robot's role. This study extends the Technology Acceptance Model by showing that, even in a highly experiential service context, perceived usefulness (efficiency) remains the primary driver of technology acceptance (Davis, 1989; Kao & Huang, 2023).

In addition, URA had a significant direct effect on both CS and eWOM (H3 and H4), supporting previous studies showing the positive effect of robotic service on customer outcomes in hospitality settings (Mukhopadhyay et al., 2023; Shah et al., 2023). The stronger effect on CS than on eWOM is reflected in the beta values: 0.643 for CS versus 0.191 for eWOM. Thus, the effect of robotic assistance on customer satisfaction is direct, whereas its effect on electronic word-of-mouth is indirect. This pattern also supports the Stimulus-Organism-Response (S-O-R) model, indicating that external stimuli, such as robot assistance, elicit internal organismic states that, in turn, affect responses (Song et al., 2019; Tung & Au, 2018). The strong positive relationship between CS and eWOM (H5) also supports the well-established relationship between satisfaction and eWOM in hospitality studies (Ruiz-Alba et al., 2022; Serra-Cantallops et al., 2020). Nevertheless, the moderate effect size of this model ($\beta = 0.297$) also indicates that satisfaction does not fully determine eWOM intentions in the context of robotic services, as this study also addresses other factors.

A notable contribution of this study was verifying the mediating effects of PN and PE in the URA-CS-eWOM model (H6a and H6b). The indirect effects were statistically significant, with PE slightly stronger than PN ($\beta = 0.102 > \beta = 0.088$). This result implies that although novelty is an important driver of customer experiences, efficiency more strongly drives the link between robotic assistance and customer satisfaction, as captured by eWOM. This study extends Expectation-Confirmation Theory (ECT) by showing that both novelty's hedonic aspect and efficiency's utilitarian aspect shape expectation confirmation and satisfaction formation in robotic service encounters (Dhiman & Jamwal, 2023; Hussain, 2016). Although important, novelty's mediating role may also decay over time, as earlier research on the novelty effect indicates a decline with repeated exposure (Wu et al., 2021; Xie et al., 2022). This suggests that to sustain customer engagement with robotic services, firms may need to innovate or add new features.

The strong moderation effect of service context on the relationship between CS and eWOM (H7) is another important theoretical contribution of this study. The moderation effect of service context ($\beta = 0.180$) on the satisfaction-eWOM relationship further confirms the significance of environment and culture in shaping how satisfied customers express their positive experiences. In Saudi Arabia, cultural factors such as collectivism, hospitality, and sharing may affect the likelihood of engaging in eWOM (Al-Adaileh & Al-Atawi, 2011; AL-Shboul, 2025). Restaurants with appropriate contextual settings may strengthen the relationship between customer satisfaction and eWOM, whereas those with inappropriate contextual settings may weaken it. This result aligns with previous studies highlighting the contextual nature of customer behavior in hospitality (Ma et al., 2023; Oh & Parks, 1996), but extends this to robotic service encounters. The model's explanatory power, with R^2 ranging from 0.589 to 0.649, suggests that the proposed framework effectively explains variance in customer outcomes. eWOM had the highest explanatory power (64.9%), followed by PE (62.5%), CS (59.6%), and PN (58.9%). These values indicate that integrating the TAM, ECT, and S-O-R models provides a comprehensive understanding of customer responses to robotic assistance in a restaurant context.

The positive Q^2 values also confirm the model's predictive relevance, reinforcing the reliability of the findings and their practical implications. The effect size values (f^2) show that URA has strong effects on both PN (1.431) and PE (1.670), reinforcing the idea that robotic assistance is a potent predictor of these perceptual states. However, the impact of CS on eWOM was limited at 0.089, which indicates that although satisfaction is important, other factors, including

the mediating factors examined in the study, as well as the moderating effect of service context, have crucial roles to play in the formation of eWOM intentions. This outcome is also important for restaurant operators, as it indicates that customer satisfaction alone may not be enough to form positive eWOM intentions; how customer satisfaction is achieved through the mediating factors is also important. Our study offers three primary implications for advancing theory in hospitality technology adoption and service robot research. First, this study extends and contributes to TAM (Davis, 1989) and ECT (Oliver, 2010) by integrating these theories in the context of service robot encounters in restaurant settings. While TAM traditionally focuses on perceived usefulness and perceived ease of use in technology acceptance, the results show that PE and PN are separate but complementary evaluative components in robotic services. We support this argument through an examination of the way in which these perceptual systems function in a sequential, rather than parallel, manner, with the presence of URA initiating both utilitarian and hedonic evaluations that, in turn, affect satisfaction outcomes.

This aligns with and extends the ECT model, which centers on the role of expectation confirmation in satisfaction. Thus, the study demonstrates the multidimensional nature of confirmation in the context of robotic service encounters, which includes not only functional confirmation (efficiency expectations) but also experiential confirmation (novelty expectations), yielding a richer understanding of the role of satisfaction in customer encounters with service innovation (Dhiman & Jamwal, 2023; Ruiz-Alba et al., 2022).

Second, our study helps clarify the important mediating roles of PN and PE in the relationship between robotic assistance and customer behavioral outcomes. Existing studies have typically examined the direct effects of service robots on customer satisfaction, or treated perceptual variables as independent predictors without specifying the mediating process. Our results show that PN and PE are not merely collateral effects of robot-based service, but essential psychological bridges linking URA to customer satisfaction and, ultimately, eWOM intentions.

We suggest that these perceptual states serve as key "cognitive filters" that shape customers' positive or negative evaluations of technological service innovations (Song et al., 2022; Xie et al., 2022). This approach offers a more refined view than the direct-effect approach, illustrating how investments in robotic servers translate into customer advocacy. In addition, the stronger mediating effect of PE compared to PN implies that utilitarian evaluations might play the role of more powerful mechanisms than hedonic novelty in perpetuating positive customer outcomes, which would expand the scope of the theory of the temporal dynamics of technology-based service innovations.

Third, we also specify a critical boundary condition in the context of the satisfaction eWOM relationship by identifying SC as a critical moderator in the satisfaction eWOM relationship. By integrating the S-O-R model with contextual contingency approaches, this study shows that the link between internal satisfaction states and external behavioral responses is not absolute but is shaped by contextual factors. This finding echoes and expands the S-O-R model by including contingencies of the environment in the organism-response relationship, highlighting the role of cultural norms, physical environment, and situational factors commonly found in Saudi Arabian restaurant settings in influencing how customers' positive states translate into electronic advocacy behaviors (Ma et al., 2023; Oh & Parks, 1996). It is the service context that either enhances or dampens the satisfaction eWOM relationship; thus, it is the service context that ensures that the models of technology-mediated customer behavior are culturally embedded (Al-Adaileh & Al-Atawi, 2011). This contextualization contributes to hospitality theory by moving beyond universalistic assumptions about customer behavior to more culturally sensitive explanations of how robot innovation in service generates differential customer reactions across diverse service contexts.

Our study offers several recommendations for restaurant managers, hospitality operators, and technology strategists in the Saudi Arabian food service industry on how to use robotic assistance strategically to improve customer satisfaction and positive eWOM. First, we propose that investments in robotic servers consider both technological functionality and the design experience. The results revealed that although PN significantly contributes to customer satisfaction, PE more strongly mediates the relationship between robotic assistance and customer outcomes.

Therefore, restaurant managers should focus not only on acquiring state-of-the-art robotic systems with impressive features, but also on ensuring reliability, accuracy, and consistency in robotic service delivery.

This is because investing in robots with strong track records in precision, accuracy, and quick service delivery is vital to exceeding customer expectations for service quality (Jain & Gupta, 2004; Yam et al., 2021). Moreover, the need for regular maintenance, software upgrades, and performance monitoring procedures should also be set to ensure the continued efficiency of the robots, as any reduction in the robots' performance will have a negative influence on the customer experience (Hwang et al., 2021). Second, our study reinforces the notion that novelty, while important, has a temporal dimension, suggesting that restaurant managers cannot rely solely on the initial 'wow factor' of robot servers to maintain customer involvement and positive e-WOM over the long term. Managers should strategically manage the novelty element by regularly introducing innovations, new robot features, or updated service scripts to keep customers engaged and excited about the robots. For example, in restaurants, robots could be programmed to display seasonal or culturally appropriate greetings or behaviors that better suit and appeal to customers in Saudi Arabia, keeping the novelty element fresh with every visit (Shams et al., 2015; Xie et al., 2022).

In addition, training employees to provide service that complements the robot service with warm and culturally sensitive human interaction could provide a unique service experience that seeks to capitalize on the novelty of the robot service, as well as the inimitability of the value of human hospitality, which is especially important in the Saudi context because of the emphasis placed on relationships and warm welcomes (Al-Adaileh & Al-Atawi, 2011).

Third, our study finds that SC moderates the relationship between customer satisfaction and eWOM, suggesting that the physical environment, cultural atmosphere, and restaurant setting play important roles in this relationship. Therefore, restaurant managers must take an integrated approach to service delivery, integrating robot service with the restaurant's ambiance, interior, and cultural setting. In the context of Saudi Arabian culture, in which hospitality is a dominant tradition with values of generosity, comfort, and connectedness, the role of the robotic servers would be to augment these cultural values, not replace them, as suggested in the study by (Ma et al., 2023; Oh & Parks, 1996).

For instance, robots could be designed to look culturally appropriate, greet customers with traditional Arabic phrases, or complement the social dining experience rather than disrupt it. Furthermore, the restaurant design would need to account for robot movement while still providing the intimate, welcoming experience expected by Saudi clientele, thereby ensuring satisfaction translates into eWOM.

Fourth, the results indicate that customer satisfaction plays a vital role in mediating the relationship between robot assistance and eWOM, although the effect size is moderate, implying that customer satisfaction alone is not enough to achieve optimal eWOM. Restaurant managers, therefore, have to develop effective customer experience management strategies that collect customer feedback at multiple touchpoints throughout the robotic service experience. Real-time customer satisfaction measures, such as digital feedback kiosks, post-meal mobile surveys, or social media listening tools, can provide valuable insights into perceptions of robotic service quality (Ruiz-Alba et al., 2022; Serra-Cantallops et al., 2020). When satisfaction dips are detected, managers should have an intervention plan in place, including individualized apologies, free items, or human service recovery, to address issues before they spill over into negative eWOM. In addition, managers can encourage satisfied customers to share their experiences on social media through strategically placed QR codes or other methods, helping translate satisfaction into e-advocacy (Lee & Youn, 2009; Verma & Yadav, 2021).

Finally, our study revealed that the use of a strategic robot assistance program should consider customer segmentation and 'dining occasions'. This matters because the differential effects of novelty and efficiency suggest managers should use different robot assistance programs for different customer segments. For example, first-time customers, such as tourists, may be more influenced by novelty features, whereas loyal customers, such as businesspeople, may be influenced more by efficiency and reliability (Tokunaga, 2013; Xie et al., 2022). Restaurants can segment their service strategies by highlighting novelty features related to robotic service for experiential customers, such as families and celebratory occasions, whereas highlighting efficiency features related to robotic service for utilitarian customers, such as businesspeople and quick meals, can be effective strategies to maximize returns on investment by matching customer expectations and needs in the Saudi Arabian market.

CONCLUSIONS

This study examined the Robotic Server Paradox in Saudi Arabian restaurants using data from 348 customers. The findings revealed that robotic assistance positively influences perceived novelty, perceived efficiency, customer satisfaction, and electronic word-of-mouth (eWOM). Novelty and efficiency both showed significant serial mediating effects, with efficiency showing a numerically stronger indirect association. Furthermore, service context significantly moderated the relationship between customer satisfaction and eWOM, highlighting the importance of culturally responsive service environments. Theoretically, the findings integrate the Technology Acceptance Model, Expectation Confirmation Theory, and the Stimulus–Organism–Response framework. Practically, restaurant managers should prioritize operational reliability, continuous innovation, and effective human–robot collaboration to enhance customer experiences.

However, the cross-sectional design and geographically restricted sample limit causal inference and generalizability. Future research should use longitudinal and cross-cultural approaches while examining additional psychological factors, robot characteristics, and customer experiences. Overall, successful robotic service integration requires balancing technological efficiency, experiential novelty, and cultural compatibility.

Limitations and Future Research

Despite its notable contributions, this study has limitations that also suggest promising directions for future research. First, although the study has made notable contributions, its cross-sectional design assesses customer perception at a single point and does not allow evaluation of how the novelty effect might diminish with repeated exposure.

Further longitudinal studies are needed to assess whether the mediation effect of novelty perception diminishes as customers become accustomed to the service robot, and how the restaurant could maintain positive customer evaluations through continuous innovation. Second, the sampling frame included only individuals from major Saudi Arabian cities, which may limit the generalizability of the findings to other cultures with different hospitality and technology adoption practices. Future comparative cross-cultural research could examine how national culture influences the relationships in the proposed model. Third, while the current study examined perceived efficiency and novelty as mediators, other psychological variables, such as trust, perceived enjoyment, and technology anxiety, also warrant examination as possible mediators/moderators in service robot interactions. Fourth, the current study examined robot assistance in general, without considering robot type or the degree of anthropomorphism. Future studies can also examine whether humanoid or non-humanoid robots elicit different outcomes in customer satisfaction and eWOM.

Lastly, other qualitative methods such as in-depth interviews or netnography may also support the results of the current study, which can elicit deeper insights into the emotional experiences of customers with robotic servers, which can significantly enrich the theoretical understanding of the Robotic Server Paradox phenomenon.

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