From Robotic Service Quality to Revisit Intention: A Warmth–Competence S–O–R Model for Restaurant Service Robots

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DOI: https://doi.org/10.47772/IJRISS.2026.100900587

Received: 30 September 2026; Accepted: 05 October 2026; Published: 17 October 2026

ABSTRACT

Service robots now greet guests, deliver dishes and clear tables in restaurants across Asia, yet how diners turn these encounters into a decision to return remains poorly explained. The robotic service quality scale (ROBOQUAL) was validated with hotel guests, does not cover the robot's physical human likeness, and was designed to measure service quality rather than to explain how it shapes customer outcomes. This conceptual paper extends ROBOQUAL in three ways: it carries the scale's dimensions into dine-in restaurants, adds robotic anthropomorphism as a design cue, and embeds both in a stimulus–organism–response (S–O–R) model with an explicit psychological mechanism. The stimuli are four perceived attributes of customer-facing robots that greet and escort guests, deliver food and drinks, clear tables and offer basic assistance: core robotic service quality, robotic task efficiency, robotic empathy and robotic anthropomorphism. The organism has two stages. Drawing on the warmth–competence framework of social cognition, diners first appraise the robot's competence and warmth; these appraisals are not dimensions of service quality but mediating judgements about the robot as an agent. Customer satisfaction, the second stage, evaluates the dining episode and mediates the effect of these appraisals on revisit intention, the single behavioural response. Nine propositions specify that functional cues act through competence and socio-emotional cues through warmth; that anthropomorphism has an inverted-U relationship with warmth; that effects reach revisit intention through serial mediation; and that the human–robot service configuration, diners' need for human interaction and prior robotic dining experience condition these paths. The paper offers a mechanism-based account of why functional and socio-emotional robot attributes are not interchangeable, and converts three untested boundary conditions into falsifiable propositions. A validation agenda for Malaysian robot-service restaurants, using experience-based survey data and partial least squares structural equation modelling, is outlined.

Keywords: Service robots; robotic service quality; warmth and competence; stimulus–organism–response; revisit intention

INTRODUCTION

Service robots have moved out of the technology showcase and into ordinary dining rooms. Machines that greet guests, carry trays between kitchen and table and clear used crockery are now a routine part of restaurant operations across Asia (L. Cheng et al., 2026; Seo & Lee, 2021). The pandemic accelerated a trajectory that was already underway, as operators sought contactless delivery and predictable throughput (Seo & Lee, 2021).

In Malaysia, adoption owes less to novelty than to arithmetic. The hospitality sector is labour-scarce and reliant on a migrant workforce, yet it is built on high-touch service traditions (Daniels & Lo, 2026), so robots have become a staffing decision rather than a marketing gesture.

Whether diners welcome that decision is a separate matter, and the evidence is divided. Some guests read robots as competent, hygienic and entertaining; others report unease about trust, the thinness of the exchange and the loss of the interpersonal warmth that hospitality is meant to supply (Chi et al., 2023; Song et al., 2022). Because a meal is a hedonic and socially embedded episode rather than a transaction, the emotional register of the encounter carries weight that a purely functional account of technology cannot capture (Ghazali et al., 2025). Even design choices that appear cosmetic matter: humanoid robots are judged the most capable yet provoke the strongest negative reactions, whereas animal-like robots are judged the warmest (W. Cheng & Hwang, 2025).

The measurement tools available to operators have not kept pace. Quantitative work has leaned on acceptance models that explain intention through expectations about performance and effort, and therefore privilege the utilitarian side of the encounter (Gursoy et al., 2019). The ROBOQUAL scale marks a shift. Grounded in social exchange theory and developed through focus groups and four validation stages with 1,600 respondents, it treats robotic service quality as a construct in its own right with three dimensions: robotic service quality, robotic task efficiency and robotic empathy (Hacikara et al., 2026). Three features of that work matter for restaurants. The scale was validated with hotel guests rather than diners. Its scope is the robot's service performance, so the robot's physical human likeness lies outside what it measures; this is a matter of the scale's scope rather than a limitation its developers identified, but it leaves room to examine appearance alongside the scale. And, as a scale-development study, its aim was measurement rather than explaining the psychological process through which the dimensions affect customer outcomes.

That third point identifies the research problem this paper addresses. Although recent studies have identified functional, emotional and relational attributes associated with customer responses to service robots, fewer studies explicitly specify the psychological mechanism through which these attributes may translate into revisit intention, or explain why functional and socio-emotional attributes should not be treated as interchangeable. Recent Malaysian evidence from real diners illustrates the difficulty: service efficiency, trust, friendliness and novelty produced a mix of complementary, competitive and indirect-only mediation effects (Ghazali et al., 2025), a pattern that, in our reading, is hard to interpret without a theory of the underlying mechanism. The same study calls for research on hybrid human–robot service, on the optimal level of anthropomorphism and on how responses change over time (Ghazali et al., 2025), and recent reviews set out research agendas for humanlike service robots and for customer experiences with robots (Rana et al., 2025; W. Zhang et al., 2024).

This paper responds by developing a conceptual model of how attributes of the robotic encounter become restaurant loyalty. The stimulus–organism–response (S–O–R) paradigm supplies the architecture (Mehrabian & Russell, 1974), and the warmth–competence framework of social cognition supplies the mechanism (Fiske et al., 2007). The stimuli are four perceived robot attributes: the three ROBOQUAL dimensions and robotic anthropomorphism. The organism has two stages. Perceived competence and perceived warmth form the appraisal stage and act as mediators; customer satisfaction forms the evaluative stage and mediates between those appraisals and behaviour. Revisit intention is the single behavioural response. Three boundary conditions are specified as moderators.

What the paper extends is the robotic service quality framework, ROBOQUAL (Hacikara et al., 2026), and it does so in three defined ways. First, it extends the framework's context, carrying its three dimensions from hotels to customer-facing robots in dine-in restaurants and specifying how items must be re-anchored to the dining encounter. Second, it extends the framework's content, adding robotic anthropomorphism, a design cue that lies outside the instrument's scope. Third, it extends the framework's nomological network. Rather than linking the dimensions directly to satisfaction, it treats them as stimuli and specifies the mechanism through which they act: functional cues through perceived competence and socio-emotional cues through perceived warmth, which explains why these attributes should have distinct and estimable effects and predicts a non-linear role for anthropomorphism. Beyond these extensions, the paper converts three boundary conditions that recent studies flag but rarely test, namely the human–robot service configuration, the diner's need for human

interaction and prior robotic dining experience, into falsifiable propositions. The model is specified for the Malaysian restaurant sector, where the operational case for robots is strong and the cultural expectation of personalised care is equally strong.

1.1 Research Objectives

Accordingly, the paper pursues five research objectives, each tied to the propositions developed in Section 6:

RO1: To conceptualise robotic service quality in customer-facing restaurant encounters by adapting the three ROBOQUAL dimensions and adding robotic anthropomorphism as a design cue.

RO2: To define perceived competence and perceived warmth and specify their role as appraisal-stage organism states that mediate between robot attributes and customer satisfaction.

RO3: To propose how the robotic service quality dimensions and anthropomorphism relate to perceived competence, perceived warmth and customer satisfaction within the S–O–R framework (P1–P4).

RO4: To specify the relationship between customer satisfaction and revisit intention, including the mediating role of satisfaction (P5–P6).

RO5: To identify the boundary conditions under which these relationships strengthen or weaken (P7–P9), and to set out how the full model can be tested empirically.

CONCEPTUAL APPROACH

The paper follows the model-building design for conceptual articles described by Jaakkola (2020), whose aim is to explain relationships between constructs by building a nomological network that is precise enough to be tested. Following MacInnis (2011), its contribution is framed as delineation and integration: it delineates which attributes of the robotic encounter matter in restaurants and integrates two established theories, S–O–R and warmth–competence, into a single explanatory account. Literature was selected purposively rather than systematically. Priority was given to studies of robots in hospitality published from 2020 onwards in peer-reviewed journals, supplemented by foundational work on service quality, satisfaction and social cognition. Each proposition is anchored in at least one empirical study and one theoretical argument, and each is stated so that it can be rejected by data (Gilson & Goldberg, 2015).

THE ROBOTIC RESTAURANT ENCOUNTER AND THE RESEARCH PROBLEM

3.1 From the Hotel Lobby to the Dining Room

A service robot is a system programmed to carry out tasks autonomously or semi-autonomously on behalf of an organisation, and a frontline service robot is one that interacts with and delivers service to customers through automated decision making (Wirtz et al., 2018). The artificial intelligence behind such units is progressing from mechanical and analytical tasks towards intuitive and empathetic ones (Huang & Rust, 2018). In restaurants, robots are deployed in both front and back of house, and their diffusion is running ahead of the evidence that would guide it (Hu & Min, 2026).

In this paper, the restaurant frontline is the customer-facing area of a dine-in restaurant, and the robotic service encounters of interest are those in which a mobile service robot serves seated or arriving guests. Four activities are covered: greeting guests and escorting them to their tables; delivering food and drinks from the kitchen pass to the table; collecting used crockery; and offering basic assistance, such as announcing an arrival, responding to simple requests or marking a celebration. Ordering and payment are excluded when they take place through self-service kiosks or table tablets, because these are self-service technologies rather than robots acting as service agents. Kitchen automation and off-premises delivery robots are also excluded. This is the

kind of deployment examined in recent Malaysian studies of robot-served restaurants (Ghazali et al., 2025; Ibrahim et al., 2024).

Three features distinguish the restaurant from the lodging settings in which most robotic service quality research has been conducted. First, the robot is co-present with the guest for the duration of the meal rather than appearing at a single touchpoint, so the encounter is continuous and observable. Second, robotic and human labour are interleaved rather than substituted, so guests judge the division of tasks as well as the machine itself (Hu & Min, 2026; Leíño Calleja et al., 2025). Third, the operational case is explicit: robots promise repeatable execution, fewer errors and consistent throughput at scale (Wirtz et al., 2018), all of which are visible to the guest in a way that back-office automation is not. The consequences reported in the literature are correspondingly mixed. Robots can standardise performance, but they can also disturb the consumption ritual and the perceived authenticity of a traditional restaurant (L. Cheng et al., 2026), and their effect on attitudes depends on how human-like they appear and on the role they are given (Qian & Wan, 2024). Six years after a research agenda for service robot implementation was set out (Belanche et al., 2020), the field still lacks a settled account of which attributes of the encounter matter most, through what process, and under what conditions.

3.2 The Malaysian Restaurant Context

Malaysia makes the question urgent rather than speculative. Its hospitality sector is labour-scarce and depends heavily on migrant workers, and frontline employees experience robot integration with a mixture of relief and anxiety (Daniels & Lo, 2026). Penang concentrates the issue. It is a heritage and culinary destination whose reputation rests largely on its food and whose visitor economy depends on the quality of the eating experience rather than on price alone (Hin et al., 2024). Robots therefore enter a market in which the operational case is compelling and service expectations are demanding, and Penang diners' satisfaction with robotic service has begun to be documented (Ibrahim et al., 2024). Malaysian research has otherwise concentrated on intention to adopt artificially intelligent customer service (Vafaei-Zadeh et al., 2025) and, more recently, on non-humanoid robots in casual dining (Ghazali et al., 2025). Comparative work shows that trust in robotic service is culturally conditioned rather than universal (Chi et al., 2023). What is missing is a mechanism-based account of which attributes of an actual robotic meal produce satisfied, returning customers, and of the conditions that strengthen or weaken those effects.

3.3 Research Gaps

Table 1 summarises the five gaps that motivate the model, the evidence on which each rests, and the way the model responds.

Table 1. Research gaps and the model's response

Gap	Evidence in recent literature	Response in this paper
G1 Contextual: robotic service quality evidence is lodging-based	ROBOQUAL was developed and validated with hotel guests (Hacikara et al., 2026); much robot service quality and experience research is hotel-based (Y. Choi et al., 2020; Rana et al., 2025)	Transfers the ROBOQUAL dimensions to dining and specifies how referent, task set and comparison standard change
G2 Methodological: reliance on scenario-based designs	Evidence on anthropomorphism and empathy is largely scenario-based, both in restaurants (W. Cheng & Hwang, 2025; Qian & Wan, 2024) and in adjacent AI service settings (Weng et al., 2026)	Validation agenda built on diners with actual robot-service experience
G3 Construct: physical human likeness sits outside the quality instrument; its optimal level is unknown	ROBOQUAL's scope is service performance rather than physical design (Hacikara et al., 2026); optimal anthropomorphism flagged as an open question for robotic dining (Ghazali et al., 2025)	Anthropomorphism added as a distinct stimulus with a curvilinear effect on warmth (P3a, P3b)
G4 Mechanism: robot attributes modelled as	Mixed mediation patterns among Malaysian diners (Ghazali et al., 2025); Seo and Lee (2025) modelled	Two-stage organism: warmth and competence appraisals

parallel predictors; the organism is a black box	service quality through value, image and satisfaction rather than robot-specific social appraisals such as warmth and competence	precede satisfaction (P1–P6)
G5 Boundary: hybrid service, interpersonal preferences and novelty decay rarely tested	Research on hybrid service and change over time called for (Ghazali et al., 2025); hybrid human–robot teams an emerging focus (Leíño Calleja et al., 2025); long-term social-robot research suggests responses may change with repeated exposure (Leite et al., 2013)	Three moderating propositions (P7–P9)

THEORETICAL FOUNDATION

4.1 The Stimulus–Organism–Response Paradigm

The S–O–R paradigm holds that environmental stimuli shape an individual's internal cognitive and affective states, and that those states drive approach or avoidance behaviour (Mehrabian & Russell, 1974). Originally formulated in environmental psychology, it has been widely adapted in hospitality and technology research to explain responses to atmospherics, digital environments and service innovations (Hsiao & Tang, 2021; Vafaei-Zadeh et al., 2025). It has also been used to model how anthropomorphic features of humanoid social robots shape hotel customers' satisfaction through perceived value (Premathilake et al., 2025), and to model robotic dining experiences (Ghazali et al., 2025). Three properties recommend it here. It accommodates both cognitive and affective evaluation, whereas acceptance models compress the encounter into beliefs about utility and effort. It is agnostic about which attributes serve as stimuli, so functional and socio-emotional cues can be specified in the same model. And it places an internal state between cue and behaviour, consistent with restaurant evidence that satisfaction transmits the effects of food healthiness and perceived value to revisit intention (H. J. Kim et al., 2013).

The paradigm has a well-known weakness. Because it says little about what the organism contains, applications often fill the box with whichever mediators are to hand, and the result explains variance without explaining process. The present model addresses that weakness by importing a theory of the organism.

4.2 Warmth and Competence as the Organism's Appraisal Layer

Research on social cognition shows that people judge other social actors along two universal dimensions: warmth, which captures perceived intent (friendliness, sincerity, care), and competence, which captures perceived ability to act on that intent (skill, efficiency, reliability) (Fiske et al., 2007). The two judgements form quickly, are made with little effort and predict both emotion and behaviour. Because people apply social rules to machines that display social cues (Epley et al., 2007), the same dimensions organise judgements of service robots. In the Humanness–Value–Loyalty model, robot appearance shapes perceived warmth and competence, which are positioned as the routes to perceived value and loyalty (Belanche et al., 2021); humanoid robots raise expectations of warmth, which shape how customers respond to robot service failure and recovery (S. Choi et al., 2021); and humanoid, animal-like and mechanoid designs produce distinct warmth and competence profiles in restaurants (W. Cheng & Hwang, 2025).

Warmth and competence are well suited to the first stage of the organism for three reasons. They are appraisals of the agent, not of the outcome, and so sit logically between what the robot does and how the guest feels about the meal. They map onto the functional–socio-emotional distinction in the service robot acceptance model (Wirtz et al., 2018), giving that distinction a psychological basis. And they are dissociable: a robot can be judged highly competent and cold, or warm and incompetent, which is exactly the pattern that makes functional and socio-emotional attributes non-substitutable.

4.3 An Integrated Account

Integrating the two theories yields a two-stage organism. In the first stage, diners appraise the robot as a social actor on competence and warmth. In the second, those appraisals feed an overall evaluation of the dining episode, customer satisfaction, which is the proximal driver of revisit intention (Oliver, 1980, 1999). This

sequence, from appraisal of the agent to evaluation of the episode, is the mechanism that the attribute-list models lack.

4.4 Positioning the Constructs in the S–O–R Model

Each construct has a single, defined position in the model (Figure 1; Table 2). The stimuli are the diner's perceptions of what the robot does and how it presents itself: core robotic service quality, robotic task efficiency and robotic empathy, the three ROBOQUAL dimensions, together with robotic anthropomorphism. The organism has two stages. Perceived competence and perceived warmth form the appraisal stage: they are judgements about the robot as an agent, formed during the encounter. They are not further dimensions of robotic service quality; they are the mediating mechanism through which service quality perceptions and anthropomorphism take effect. Customer satisfaction forms the evaluative stage: it summarises the dining episode, is the outcome of the two appraisals, and in turn mediates their effect on behaviour. Revisit intention is the model's only response.

Satisfaction therefore plays a double role. It is an outcome of the appraisal stage (P4a and P4b) and a mediator between that stage and revisit intention (P5 and P6), but it is not a final response in its own right. This sequence follows the cognitive model of satisfaction, in which evaluations of an experience precede and drive loyalty intentions (Oliver, 1980, 1999). Need for human interaction, the human–robot service configuration and prior robotic dining experience sit outside the S–O–R chain as moderators that change the strength of specific paths (P7–P9).

CONCEPTUAL DOMAIN OF THE CONSTRUCTS

5.1 Robotic Service Quality and Its Dimensions

Service quality is the customer's evaluation of the overall excellence of a service, and its behavioural consequences for loyalty are among the most durable findings in service marketing (Zeithaml et al., 1996). Quality delivered by robots is distinguishable from quality delivered by people, because instruments designed for human providers presume human agency (Hacikara et al., 2026). ROBOQUAL captures robotic service quality through three dimensions (Hacikara et al., 2026). To avoid confusing the overall construct with its first dimension, this paper refers to that dimension as *core robotic service quality*: the guest's assessment of whether the robot delivers the service accurately, dependably and as promised. *Robotic task efficiency* denotes the robot's capacity to execute its functions with speed, precision and sustained concentration. In a restaurant it is unusually observable: the interval between kitchen pass and table, the accuracy of routing to the correct table and the ability to move through a crowded floor are apparent to the guest without interpretation. *Robotic empathy* refers to the robot's perceived capacity to recognise and respond appropriately to the customer's emotional state. Artificial empathy has been specified through perspective taking, empathic concern and emotional contagion (Weng et al., 2026), and studied in hospitality robots (Zhu et al., 2025) and in chatbots handling service recovery (Guo et al., 2026). What unites them is that the empathy at issue is simulated rather than felt. For the model, that is immaterial: the customer responds to the display, not to its ontological status.

The model treats the three dimensions as distinct first-order stimuli rather than collapsing them into a single index. This is deliberate. The dimensions are expected to act through different appraisals, and an aggregate score would conceal the very difference the model is built to explain. A higher-order specification remains available as a robustness check (Sarstedt et al., 2019).

Robotic service quality is therefore defined here as the diner's evaluation of the service a robot delivers during the encounter, captured by three attributes: core service quality (accuracy and dependability), task efficiency (speed and precision) and empathy (emotional responsiveness). Several attributes found in adjacent literatures are treated differently, by design. Perceived usefulness and ease of use are beliefs about a technology that drive adoption intention (Gursoy et al., 2019); they belong to acceptance models rather than to the post-encounter evaluation of service, and are excluded. Responsiveness to requests is treated as part of core service quality, and responsiveness to feelings as part of empathy, rather than as separate dimensions. Appearance is not a quality attribute but a design cue, and is modelled separately as anthropomorphism (Section 5.2). The three attributes connect to the organism in a specific way: core service quality and task efficiency supply evidence

about the robot's ability and are expected to shape perceived competence, whereas empathy supplies evidence about its intent towards the guest and is expected to shape perceived warmth.

5.2 Robotic Anthropomorphism

Anthropomorphism is the attribution of human characteristics, including appearance, emotion and behaviour to non-human agents (Epley et al., 2007). In service robot research, it has been treated as a multidimensional property spanning mission completion, user sensory experience, artificial intelligence and unique human characteristics (S. Zhang et al., 2022), and as a set of features (appearance, voice and response capability) whose effects on hotel customers' satisfaction run through perceived value (Premathilake et al., 2025). Evidence from the employee perspective adds that anthropomorphism can be dual-natured, evoking both perceived warmth and awareness of the threat of automation among frontline staff (Yang et al., 2024). Although that evidence concerns employees rather than diners, it supports treating anthropomorphism as a cue that can cut both ways. This paper defines robotic anthropomorphism as the degree of human likeness the diner perceives in the robot's form, voice and movement. It is a perceptual property of the encounter rather than an engineering specification, because it is the guest's reading of the machine, not its build sheet, that drives response. Anthropomorphism is distinct from robotic empathy: the former concerns what the robot looks and sounds like, the latter what it does in response to the guest's feelings. A robot with a screen for a face may still respond empathically, and a strongly humanoid robot may not.

5.3 Perceived Competence and Perceived Warmth

Perceived competence is the diner's judgement that the robot is capable, skilful and reliable in performing its service role. Perceived warmth is the diner's judgement that the robot is friendly, attentive and well-intentioned towards the guest (Belanche et al., 2021; Fiske et al., 2007). Both are appraisals of the robot as an agent rather than evaluations of the meal, and both are positioned as mediators in the appraisal stage of the organism. They differ from the stimuli in level of abstraction: task efficiency refers to observable performance (the tray arrived quickly and at the right table), whereas competence is the inference the guest draws about the agent (this robot knows what it is doing).

Because robotic empathy is linked to perceived warmth (P2), the two constructs must be kept conceptually distinct. Robotic empathy is a stimulus: the diner's perception of a behavioural display, namely whether the robot noticed and responded appropriately to the guest's emotional state during a specific episode, such as acknowledging a delay. Perceived warmth is an organism state: an inference about the robot's general social intent and affective orientation towards the guest, such as whether it seems friendly and well-meaning. The first is episodic and behavioural; the second is dispositional and attributional. A diner may judge a robot warm because of its voice, form or courtesy without witnessing any empathic response, and may observe an empathic script yet discount it as programmed rather than warm. Warmth is therefore shaped by more than empathy, including anthropomorphism (P3b). For measurement, empathy items should refer to responses observed during the visit and warmth items to trait-like judgements of the robot, with discriminant validity assessed using the heterotrait–monotrait ratio (Henseler et al., 2015).

5.4 Customer Satisfaction and Revisit Intention

Customer satisfaction is the overall post-consumption evaluation a guest forms of the dining experience, and it has long been positioned as the pivot between perception and behaviour (H. J. Kim et al., 2013; Oliver, 1980). Revisit intention is the stated likelihood of returning to the same restaurant. Its established antecedents include emotional response and switching barriers (Han et al., 2009) as well as food quality (Namkung & Jang, 2007), and studies of robotic dining have generally adopted the construct intact (Amin et al., 2025). Both constructs are retained in their conventional form. In the model, satisfaction is the evaluative stage of the organism and a mediator, while revisit intention is the sole response.

5.5 Transferring a Lodging Instrument to Dining

Because the model borrows its quality dimensions from an instrument validated in hotels, the transfer deserves to be treated as a substantive step. Three shifts occur. The referent changes: a hotel guest evaluating a delivery

robot assesses an isolated errand, whereas a diner assesses a sequence of acts distributed across a meal, so items must refer to the encounter rather than the property. The task set changes: adaptability in lodging often means responding to an unusual request, whereas in dining it more often means navigating a changed floor layout or an obstructed aisle, which is a different capability and is judged differently. And the comparison standard changes, because restaurant robots work in view of human servers whose performance provides a co-

ntinuous benchmark, and because placing a machine in a familiar dining ritual can alter how the service is read (L. Cheng et al., 2026). Items therefore require re-specification and fresh validation rather than translation, and discriminant validity against the original dimensions should be established before structural claims are made. Table 2 summarises the working definitions adopted.

Table 2. Focal constructs, positions in the S–O–R model and working definitions

Construct	Role	Working definition adopted	Anchor
Core robotic service quality	Stimulus (functional cue)	Diner's assessment of whether the robot delivers the service accurately, dependably and as promised	Hacikara et al. (2026)
Robotic task efficiency	Stimulus (functional cue)	Perceived capacity of the robot to execute its tasks with speed, precision and sustained concentration	Hacikara et al. (2026); El-Said & Al Hajri (2022)
Robotic empathy	Stimulus (socio-emotional cue)	Perceived capacity of the robot to recognise and respond appropriately to the diner's emotional state	Hacikara et al. (2026); Weng et al. (2026)
Robotic anthropomorphism	Stimulus (socio-emotional cue)	Degree of human likeness the diner perceives in the robot's form, voice and movement	Epley et al. (2007); Yang et al. (2024)
Perceived competence	Organism, stage 1 (appraisal); mediator	Judgement that the robot is capable, skilful and reliable in its service role	Fiske et al. (2007); Belanche et al. (2021)
Perceived warmth	Organism, stage 1 (appraisal); mediator	Judgement that the robot is friendly, attentive and well-intentioned towards the diner	Fiske et al. (2007); Belanche et al. (2021)
Customer satisfaction	Organism, stage 2 (evaluation); mediator	Overall post-consumption evaluation of the dining experience	Oliver (1980); H. J. Kim et al. (2013)
Revisit intention	Response	Stated likelihood of returning to the same restaurant	Han et al. (2009); Amin et al. (2025)
Human–robot service configuration	Moderator (P7)	Extent to which human staff remain visibly involved in delivering the robotic service	Leíño Calleja et al. (2025); Hu & Min (2026)
Need for human interaction	Moderator (P8a, P8b)	Importance the diner places on contact with human employees during service	Dabholkar & Bagozzi (2002); Belanche et al. (2021)
Prior robotic dining experience	Moderator (P9)	Extent of the diner's previous robot-served meals	Leite et al. (2013); Ghazali et al. (2025)

PROPOSITION DEVELOPMENT

The propositions follow the integrated architecture. Functional cues describe what the robot accomplishes; socio-emotional cues describe how it presents itself while doing so. The former are expected to act chiefly through competence and the latter chiefly through warmth, with one important exception: anthropomorphism, which signals both. Keeping these routes distinct is what allows the framework to answer the practical question operators face, which is where to invest.

6.1 Functional Cues and Perceived Competence

Competence judgements rest on evidence of ability, and in a restaurant that evidence is delivered tray by tray. When the robot brings the correct order to the correct table without incident, the guest has direct grounds for inferring capability. Core service quality and task efficiency both emerged as distinct dimensions in the development of ROBOQUAL (Hacikara et al., 2026). In robot-service restaurants, speed of service has been found to drive experience satisfaction (El-Said & Al Hajri, 2022), Indian evidence points in the same direction (Sharma et al., 2023), and service efficiency improved attitudes and revisit intentions among Malaysian diners (Ghazali et al., 2025). Seen through social exchange theory, prompt and reliable execution is a utilitarian reward that lowers the cost of the interaction (H. Kim et al., 2022). None of these studies tested perceived competence as a mediator. Drawing on their findings and on the warmth–competence framework, we propose that the effects of functional performance pass through the guest's inference about the agent's ability.

P1a: *Core robotic service quality is positively associated with perceived competence of the service robot.*

P1b: *Robotic task efficiency is positively associated with perceived competence of the service robot.*

6.2 Socio-Emotional Cues and Perceived Warmth

Warmth judgements rest on evidence of intent towards the self. Robotic empathy supplies that evidence most directly: a robot that acknowledges a delay, adjusts its tone to a frustrated guest or responds to a child's excitement displays orientation towards the customer. In hospitality, robots displaying higher artificial empathy evoked stronger automated social presence and greater willingness to co-create (Zhu et al., 2025). Evidence from adjacent AI service settings points the same way. In online medical-consultation scenarios that manipulated empathy and anthropomorphism together, high artificial empathy improved satisfaction with the interaction through perceived intimacy and then social bonding (Weng et al., 2026), and in scenario-based chatbot service recovery, empathic responses raised relational energy and perceived intimacy (Guo et al., 2026). Although this evidence comes from AI-mediated rather than restaurant interactions, and none of it measured warmth as such, taken together it suggests that empathic displays are read as signs of social intent. We therefore theorise that robotic empathy shapes perceived warmth. The restaurant setting adds a qualification worth carrying into testing: empathy demands in dining are episodic, concentrated at moments of delay, error or complaint, rather than continuous.

P2: *Robotic empathy is positively associated with perceived warmth of the service robot.*

Anthropomorphism is more complicated, because human likeness signals both ability and intent. Human-like cues lead customers to treat the machine as a social actor and to attribute mind to it, which raises perceived intelligence and capability (Blut et al., 2021; Wirtz et al., 2018). Humanoid robots were judged the most capable of three design types in restaurant scenarios (W. Cheng & Hwang, 2025), and anthropomorphic robots fostered more positive attitudes towards restaurants than mechanical-looking ones (Qian & Wan, 2024).

P3a: *Robotic anthropomorphism is positively associated with perceived competence of the service robot.*

The relationship with warmth is unlikely to be linear. Uncanny-valley theory holds that moderate human likeness invites social engagement, but as resemblance approaches the human without achieving it, the robot can become eerie (Mori et al., 2012). Anthropomorphising consumer robots increased perceived warmth but decreased liking (S. Y. Kim et al., 2019); humanoid robots elicited discomfort and compensatory consumer behaviour (Mende et al., 2019); and in restaurant scenarios, animal-like robots were judged the warmest while humanoid robots, though judged the most capable, triggered the strongest negative reactions (W. Cheng & Hwang, 2025). The optimal level of human likeness remains an open question for robotic dining (Ghazali et al., 2025). These findings do not establish an inverted-U relationship directly; rather, taken together with uncanny-valley theory, they motivate the present proposition that warmth may peak at an intermediate level of human likeness.

P3b: *Robotic anthropomorphism has an inverted-U relationship with perceived warmth, such that warmth rises with human likeness up to a moderate level and declines thereafter.*

6.3 From Appraisal to Satisfaction

Once formed, warmth and competence judgements are expected to shape the guest's evaluation of the episode. Competence assures the guest that the core service will be delivered, reducing uncertainty about the meal; warmth supplies the sense of being cared for that diners expect from hospitality. In frontline services, robot warmth and competence have been modelled as the appraisals through which human likeness reaches perceived value and loyalty (Belanche et al., 2021). In robot-service restaurants, trust influenced revisit intention through satisfaction (Ghazali et al., 2025), and perceived intelligence and social presence shaped revisit intention (Amin et al., 2025); in our reading, these constructs are close to competence and warmth respectively, although neither study measured warmth or competence directly. A meta-analysis of more than 100 samples found that anthropomorphism raises satisfaction by way of perceived intelligence and related appraisals of the agent (Blut et al., 2021). No prior study has tested the full sequence proposed here; these findings motivate rather than establish it.

P4a: *Perceived competence of the service robot is positively associated with customer satisfaction.*

P4b: *Perceived warmth of the service robot is positively associated with customer satisfaction.*

6.4 Satisfaction and Revisit Intention

The satisfaction–loyalty link is the most consistently supported relationship in the model. Satisfaction carries the effect of perceived value and food healthiness to revisit intention in restaurants (H. J. Kim et al., 2013), transmits the effects of hedonic and utilitarian value on returning (Le et al., 2024), and transmits the effect of service quality to revisit intention in robotic restaurants (Seo & Lee, 2025). Emotional response and switching barriers qualify the strength of the link without displacing it (Han et al., 2009).

P5: *Customer satisfaction is positively associated with revisit intention in robot-service restaurants.*

6.5 The Mediating Architecture

Taken together, P1 to P5 imply a serial chain: robot attributes shape appraisals of the agent, appraisals shape satisfaction, and satisfaction shapes the decision to return. The S–O–R logic predicts that the stimuli reach behaviour only through the organism. A rival account, supported by the finding that performance efficacy had a direct-only effect on revisit intention among Malaysian diners (Ghazali et al., 2025), holds that some functional attributes bypass evaluation and act directly as reasons to return, for example when a robot-served outlet is simply faster than the alternatives. The model states the S–O–R prediction and identifies the rival as a competing specification to be tested.

P6: *The effects of robotic service quality dimensions and robotic anthropomorphism on revisit intention are transmitted serially through perceived competence or perceived warmth and then customer satisfaction.*

6.6 Boundary Conditions

The model specifies three conditions under which the strength of these paths should change. Each has been flagged in recent work but rarely tested.

The first is the human–robot service configuration, defined as the extent to which human staff remain visibly involved in delivering the robotic service. In hybrid configurations, robots carry trays while human servers greet guests, take orders and handle problems. The robot's own warmth matters less here, because human staff supply the interpersonal care that satisfaction requires; the robot is judged chiefly as a tool, so its competence carries more weight. Work on hybrid frontline teams examines how the robot's automated social presence is experienced when robots and employees serve customers together (Leíño Calleja et al., 2025), human

involvement improved recovery perceptions after robot failures in restaurants (W. Cheng & Hwang, 2025) and can compensate for inadequate recovery by non-humanoid robots (S. Choi et al., 2021), acceptance of non-anthropomorphic robots rose when they were given collaborative roles (Qian & Wan, 2024), and research on when and how to deploy restaurant robots emphasises the role of human staff in facilitating customer adoption (Hu & Min, 2026).

> ***P7:*** *The human–robot service configuration moderates the appraisal–satisfaction paths, such that greater visible human involvement weakens the effect of perceived warmth on satisfaction and strengthens the effect of perceived competence on satisfaction.*

The second is the diner's need for human interaction: the importance a customer places on contact with human employees during service. This trait conditions evaluations of technology-based service (Dabholkar & Bagozzi, 2002; Meuter et al., 2005), and the evidence on robots suggests that it works in two directions at once. Customers who prioritise social connection are more responsive to empathic robots, perceiving stronger automated social presence (Zhu et al., 2025), which implies that empathic displays register more readily as warmth. Yet robot warmth translated into value expectations more strongly for customers with a lower need for social interaction (Belanche et al., 2021), and humanoid robots can provoke compensatory responses among consumers who feel their human identity is challenged (Mende et al., 2019). Diners who want human contact may therefore notice a robot's warmth but still not find it a satisfying substitute for a person.

> ***P8a:*** *Need for human interaction strengthens the relationship between robotic empathy and perceived warmth.*

> ***P8b:*** *Need for human interaction weakens the relationship between perceived warmth and customer satisfaction.*

The third is prior robotic dining experience. Research on long-term social-robot interaction suggests that novelty and social responses may change with repeated exposure (Leite et al., 2013). Restaurant evidence shows that novelty matters: experience novelty affected satisfaction with robot-service restaurants, and novelty seeking moderated that effect (El-Said & Al Hajri, 2022), while among Malaysian diners the satisfaction gained from robot novelty differed between high and low novelty seekers (Ghazali et al., 2025). A human-like robot is striking on first encounter and may be unremarkable by the fifth. We therefore expect the warmth that anthropomorphism evokes to diminish with exposure, whereas functional performance is judged on its merits at every visit.

> ***P9:*** *Prior robotic dining experience moderates the relationship between robotic anthropomorphism and perceived warmth, such that the relationship is weaker for diners with more prior experience.*

Figure 1 presents the integrated framework.

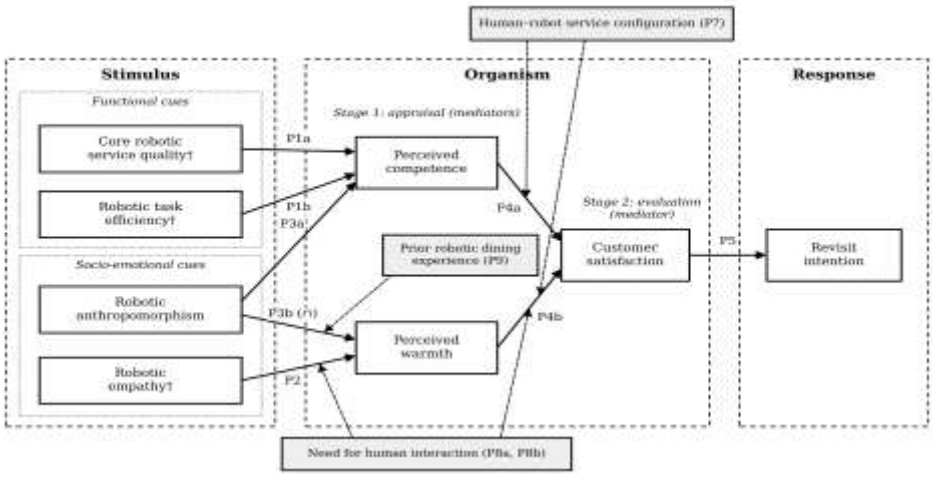


Figure 1. Warmth–competence S–O–R model of robotic restaurant service

Note: † dimension of ROBOQUAL (Hacikara et al., 2026). Solid arrows denote direct propositions; dashed arrows denote moderating propositions; ∩ denotes an inverted-U effect. P6 (serial mediation) spans the stimulus → organism → response chain.

DISCUSSION

7.1 Theoretical Contributions

The model makes three theoretical moves. First, it extends robotic service quality theory to a new setting. Rather than replicating ROBOQUAL in restaurants, it treats the transfer from lodging to dining as a question of scope conditions, identifying three features of dining (continuous co-presence, interleaving with human labour and the hedonic weight of the occasion) that should alter both measurement and structural relationships. It also restores the physical dimension of the robot that lies outside the instrument's scope, in the one setting where the machine remains in view throughout the service episode.

Second, it specifies the organism. Much S–O–R research on robots places a single mediator, typically satisfaction, trust or attitude, between stimuli and response. By importing the warmth–competence framework, the model explains why functional and socio-emotional attributes have different effects: they supply evidence for different judgements about the agent. This makes the competing intuitions in the literature, that customers value robots chiefly for reliability or chiefly for social presence, a matter for estimation rather than assertion. It also yields a non-obvious prediction, the inverted-U effect of anthropomorphism on warmth, which a linear attribute-list model cannot generate.

Third, it formalises boundary conditions. Hybrid service teams, interpersonal service preferences and novelty decay are routinely mentioned as limitations in empirical studies. Stating them as moderating propositions turns caveats into theory: if the coefficients shift as predicted, the model explains when robot attributes matter as well as whether they do. If the S–O–R prediction of full mediation fails and direct functional paths survive (P6), the paradigm requires modification for robotic contexts. Either result is informative.

7.2 Managerial Implications

For restaurant operators, the framework turns a procurement question into an evidence-based one. Robots are usually sold on throughput, but if warmth carries independent weight in satisfaction, a unit optimised solely for delivery speed will under-deliver against expectations the operator has not measured. The inverted-U proposition carries a direct design implication: more human likeness is not always better, and moderately anthropomorphic or animal-like designs may offer more warmth per ringgit than near-human ones. P7 informs the division of labour. Where human staff remain visible and handle recovery, operators can choose robots on competence and invest less in social features; where robots replace front-of-house staff more fully, the robot's warmth becomes a requirement rather than an extra.

Deployment sequencing follows from the same logic. The first robot an outlet introduces should be placed where its competence is most visible and its social limitations least exposed, which usually means transport tasks during busy periods rather than greeting or complaint handling. Staff communication matters for the same reason: when servers present the robot as an assistant that frees them for guest contact, the human benchmark works for the operator rather than against it. P8 suggests segmentation: guests who value human contact will notice an empathic robot but will not accept it as a substitute for a person, so outlets serving them, such as family celebrations or fine dining, should keep a human at the moments that matter. P9 cautions against reading early customer enthusiasm as durable; operators should track satisfaction among repeat guests separately from first-time visitors. For robot developers, the separation of anthropomorphism from empathy matters commercially, because human-like form and emotionally responsive behaviour are different engineering investments with different costs. For policymakers supporting automation, the framework indicates that public support is best directed at the evidence base and at training for the human–robot division of labour, rather than at capital subsidy alone.

7.3 Rival Explanations

Three rival accounts deserve to be specified rather than assumed away. The first is novelty, which P9 addresses in part: early encounters may generate satisfaction that reflects curiosity rather than service evaluation, in which case effects would weaken as exposure accumulates. The second is attribution under failure. When an order is late or wrong, guests must decide whether the machine, the kitchen or the operator is responsible, and these attributions differ from those made about human staff (S. Choi et al., 2021; H. Kim et al., 2022). A model estimated only on uneventful encounters will overstate the stability of the relationships, so service failure should be recorded. The third is the food. Satisfaction with a robotic restaurant reflects the meal as well as the robot (Namkung & Jang, 2007), and food quality should therefore be controlled so that robot effects are not confounded with kitchen performance.

7.4 Scope Conditions

The framework is bounded in three ways. It addresses the four customer-facing activities defined in Section 3.1, performed by robots the guest can see and whose task outcomes the guest can judge; ordering and payment kiosks, kitchen automation and back-of-house logistics fall outside it, since they emit few of the cues the model treats as stimuli. It assumes a discretionary occasion in which the guest could have chosen another outlet, which is what makes revisit intention a meaningful response; captive settings such as institutional canteens would require a different dependent variable. And it is specified at the level of the encounter rather than the brand. A guest may be satisfied with a robotic service episode and still decline to return for reasons unrelated to the robot, which is why switching barriers should be measured alongside the focal constructs (Han et al., 2009). Within these bounds the propositions should apply across restaurant formats, although format itself is likely to condition the relative weight of competence and warmth.

AGENDA FOR EMPIRICAL VALIDATION

The model is designed for testing with survey data from diners who have actually been served by robots, rather than respondents reacting to written or video scenarios. This addresses the hypothetical bias that limits the external validity of much existing work. Penang offers a suitable setting, combining a dense and internationally known dining sector (Hin et al., 2024) with documented robot adoption in its restaurants (Ibrahim et al., 2024) and a labour-scarce hospitality workforce (Daniels & Lo, 2026). Items for the three robotic service quality dimensions can be adapted from ROBOQUAL (Hacikara et al., 2026); anthropomorphism from established service robot measures (Blut et al., 2021; S. Zhang et al., 2022); warmth and competence from validated social-perception items used with robots (Belanche et al., 2021); need for human interaction from Dabholkar and Bagozzi (2002); and satisfaction and revisit intention from validated restaurant instruments (Han et al., 2009; H. J. Kim et al., 2013). The human–robot service configuration can be coded at outlet level from structured observation, and prior experience measured as the number of previous robot-served meals.

Instrument development should precede estimation. Adapted items require expert review for face validity in dining and cognitive pre-testing with diners, since wording written for hotel guests can be read differently at a table. A pilot study allows the measurement model to be screened before full fieldwork, and screening questions should establish genuine exposure rather than familiarity. Minimum sample size should be set by power analysis (Faul et al., 2009) and checked against the inverse square root method (Kock & Hadaya, 2018); given the moderators, a sample of at least 300 to 400 diners drawn from outlets with contrasting service configurations is advisable.

Partial least squares structural equation modelling (PLS-SEM) suits the model, given the number of latent constructs, the inclusion of a non-linear term and the predictive orientation of the inquiry (Hair et al., 2019). Measurement assessment should report indicator reliability, internal consistency, convergent validity and discriminant validity, using the heterotrait–monotrait ratio (Henseler et al., 2015). Because the design is single-source, common method bias warrants procedural remedies at the design stage (Podsakoff et al., 2003) and statistical checks such as the full collinearity test (Kock, 2015). Table 3 maps each proposition to its test.

Table 3. Propositions and recommended empirical tests

Proposition	Relationship	Expected effect	Recommended test in PLS-SEM
P1a, P1b	Core service quality; task efficiency → competence	Positive	Path coefficients with bootstrapped confidence intervals
P2	Robotic empathy → warmth	Positive	Path coefficient
P3a	Anthropomorphism → competence	Positive	Path coefficient
P3b	Anthropomorphism → warmth	Inverted U	Quadratic term (Basco et al., 2022)
P4a, P4b	Competence; warmth → satisfaction	Positive	Path coefficients; f^2 to compare relative weight
P5	Satisfaction → revisit intention	Positive	Path coefficient
P6	Stimuli → appraisal → satisfaction → revisit intention	Serial mediation	Specific indirect effects; compare with rival model containing direct stimulus → revisit paths
P7	Configuration × competence; configuration × warmth → satisfaction	Warmth path weaker, competence path stronger with greater human involvement	Multi-group analysis after MICOM (Henseler et al., 2016)
P8a, P8b	Need for human interaction × empathy → warmth; need for human interaction × warmth → satisfaction	Positive (P8a); negative (P8b) interaction	Two-stage interaction terms
P9	Prior experience × anthropomorphism → warmth	Negative interaction	Two-stage interaction term; longitudinal follow-up
Model	Out-of-sample prediction of revisit intention	—	PLSpredict (Shmueli et al., 2019)

Beyond the initial cross-sectional test, four extensions would strengthen inference. A longitudinal panel following the same diners across visits would test P9 directly and separate novelty from evaluation. Field experiments varying robot design within the same outlet would provide causal evidence for P3b. Comparison across service formats would establish whether competence dominates in quick service and warmth in full service. And cross-national comparison, for example between Malaysia and Indonesia, would test whether the warmth path is culturally conditioned, as the evidence on trust suggests (Chi et al., 2023).

CONCLUSION

Restaurants are adopting service robots faster than research can tell them which robot attributes earn a return. This paper has argued that the answer requires a model that distinguishes functional from socio-emotional attributes, explains their effects through the guest's appraisal of the robot as competent and warm, routes both through satisfaction, and is specified for dining rather than borrowed from lodging. The nine propositions set out here are intended to be falsifiable rather than comprehensive. Their value lies in making explicit a set of claims that current practice already assumes, and in identifying the conditions under which those claims should fail.

DECLARATIONS

Acknowledgement and funding: The authors acknowledge Universiti Teknologi MARA Cawangan Pulau Pinang for support through the Knowledge Advancement Through Social Science for Community (KATSS) 2025 research grant (Reference No. 600-UiTMPP [RMU.5/1][KATSS/20/2025]).

Conflict of interest: The authors declare no conflict of interest.

Ethical approval: This conceptual paper forms part of a wider research project that received ethical approval from the Institutional Ethics Committee of Universiti Teknologi MARA, Dungun Campus (Approval No. REC/09/2025 (PG/MR/548)). No human participants were involved in preparing this paper. In the project's empirical phase, all participants will provide informed consent before participation; their involvement will be voluntary, and confidentiality, anonymity, privacy and the right to withdraw at any time will be maintained throughout, in accordance with the Declaration of Helsinki.

Data availability: No data were generated or analysed in this conceptual paper.

Declaration of generative AI use: During the preparation of this manuscript, the authors used Claude (Anthropic) to assist with structuring the conceptual framework and revising the text to enhance clarity. After using this tool, the authors reviewed, edited and verified all content, including every cited source, and take full responsibility for the content of the publication.

REFERENCES

1. Amin, M., Parvez, M. O., Rasool, S., Aureliano-Silva, L., & Dang, A. (2025). Human–robot interaction attributes at the restaurants: Will it enhance revisit intentions? *Journal of Hospitality and Tourism Technology*, *16*(5), 1024–1045. https://doi.org/10.1108/JHTT-10-2024-0694
2. Basco, R., Hair, J. F., Ringle, C. M., & Sarstedt, M. (2022). Advancing family business research through modeling nonlinear relationships: Comparing PLS-SEM and multiple regression. *Journal of Family Business Strategy*, *13*(3), Art. 100457. https://doi.org/10.1016/j.jfbs.2021.100457
3. Belanche, D., Casaló, L. V., Flavián, C., & Schepers, J. (2020). Service robot implementation: A theoretical framework and research agenda. *The Service Industries Journal*, *40*(3–4), 203–225. https://doi.org/10.1080/02642069.2019.1672666
4. Belanche, D., Casaló, L. V., Schepers, J., & Flavián, C. (2021). Examining the effects of robots' physical appearance, warmth, and competence in frontline services: The Humanness-Value-Loyalty model. *Psychology & Marketing*, *38*(12), 2357–2376. https://doi.org/10.1002/mar.21532
5. Blut, M., Wang, C., Wünderlich, N. V., & Brock, C. (2021). Understanding anthropomorphism in service provision: A meta-analysis of physical robots, chatbots, and other AI. *Journal of the Academy of Marketing Science*, *49*(4), 632–658. https://doi.org/10.1007/s11747-020-00762-y
6. Cheng, L., Li, X., Liu, B., & Cheng, L. (2026). When traditional restaurants meet service robots: Consumption rituals, authenticity and brand trust. *International Journal of Hospitality Management*, *134*, Art. 104579. https://doi.org/10.1016/j.ijhm.2026.104579
7. Cheng, W., & Hwang, J. (2025). Robots' anthropomorphic designs: Psychological mechanism of consumer acceptance in restaurant contexts of service success, failure, and recovery. *International Journal of Hospitality Management*, *131*, Art. 104322. https://doi.org/10.1016/j.ijhm.2025.104322
8. Chi, O. H., Chi, C. G., Gursoy, D., & Nunkoo, R. (2023). Customers' acceptance of artificially intelligent service robots: The influence of trust and culture. *International Journal of Information Management*, *70*, Art. 102623. https://doi.org/10.1016/j.ijinfomgt.2023.102623
9. Choi, S., Mattila, A. S., & Bolton, L. E. (2021). To err is human(-oid): How do consumers react to robot service failure and recovery? *Journal of Service Research*, *24*(3), 354–371. https://doi.org/10.1177/1094670520978798
10. Choi, Y., Choi, M., Oh, M., & Kim, S. (2020). Service robots in hotels: Understanding the service quality perceptions of human-robot interaction. *Journal of Hospitality Marketing & Management*, *29*(6), 613–635. https://doi.org/10.1080/19368623.2020.1703871
11. Dabholkar, P. A., & Bagozzi, R. P. (2002). An attitudinal model of technology-based self-service: Moderating effects of consumer traits and situational factors. *Journal of the Academy of Marketing Science*, *30*(3), 184–201. https://doi.org/10.1177/0092070302303001
12. Daniels, G., & Lo, R. (2026). Robots at the table: Unveiling employee experiences of robot integration in Malaysia's hospitality industry. *Advances in Southeast Asian Studies*, *19*(1), G1–G24. https://doi.org/10.14764/10.ASEAS-0140
13. El-Said, O., & Al Hajri, S. (2022). Are customers happy with robot service? Investigating satisfaction with robot service restaurants during the COVID-19 pandemic. *Heliyon*, *8*(3), Art. e08986. https://doi.org/10.1016/j.heliyon.2022.e08986

14. Epley, N., Waytz, A., & Cacioppo, J. T. (2007). On seeing human: A three-factor theory of anthropomorphism. *Psychological Review*, *114*(4), 864–886. https://doi.org/10.1037/0033-295X.114.4.864
15. Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149
16. Fiske, S. T., Cuddy, A. J. C., & Glick, P. (2007). Universal dimensions of social cognition: Warmth and competence. *Trends in Cognitive Sciences*, *11*(2), 77–83. https://doi.org/10.1016/j.tics.2006.11.005
17. Ghazali, E. M., Mutum, D. S., & Cheah, J.-H. (2025). Dining with robots: An integrated perspective on functional, emotional and relational dimensions of customer experience. *Electronic Markets*, *35*(1), Art. 57. https://doi.org/10.1007/s12525-025-00797-5
18. Gilson, L. L., & Goldberg, C. B. (2015). Editors' comment: So, what is a conceptual paper? *Group & Organization Management*, *40*(2), 127–130. https://doi.org/10.1177/1059601115576425
19. Guo, J., Yang, X., Wang, S., & Jiang, T. (2026). Feeling human, acting machine: The influence of artificial empathy on customer engagement behaviour in service recovery. *International Journal of Human-Computer Studies*, *211*, Art. 103794. https://doi.org/10.1016/j.ijhcs.2026.103794
20. Gursoy, D., Chi, O. H., Lu, L., & Nunkoo, R. (2019). Consumers acceptance of artificially intelligent (AI) device use in service delivery. *International Journal of Information Management*, *49*, 157–169. https://doi.org/10.1016/j.ijinfomgt.2019.03.008
21. Hacikara, A., Murphy, K., Zhang, T., Hancer, M., & Gursoy, D. (2026). Redefining service quality: Development and validation of the robotic service quality scale. *International Journal of Hospitality Management*, *134*, Art. 104560. https://doi.org/10.1016/j.ijhm.2026.104560
22. 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. https://doi.org/10.1108/EBR-11-2018-0203
23. Han, H., Back, K.-J., & Barrett, B. (2009). Influencing factors on restaurant customers' revisit intention: The roles of emotions and switching barriers. *International Journal of Hospitality Management*, *28*(4), 563–572. https://doi.org/10.1016/j.ijhm.2009.03.005
24. Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8
25. Henseler, J., Ringle, C. M., & Sarstedt, M. (2016). Testing measurement invariance of composites using partial least squares. *International Marketing Review*, *33*(3), 405–431. https://doi.org/10.1108/IMR-09-2014-0304
26. Hin, Y. S., Mohamed, B., Marzuki, A., & Mohd Paisar, S. (2024). Travel motivations of domestic tourists to Penang, Malaysia. *Planning Malaysia*, *22*(33). https://doi.org/10.21837/pm.v22i33.1565
27. Hsiao, C.-H., & Tang, K.-Y. (2021). Who captures whom – Pokémon or tourists? A perspective of the stimulus-organism-response model. *International Journal of Information Management*, *61*, Art. 102312. https://doi.org/10.1016/j.ijinfomgt.2021.102312
28. Hu, Y., & Min, H. (2026). Crossing the innovation chasm: When and how to deploy service robots and facilitate customer adoption at restaurants. *Journal of Hospitality and Tourism Technology*, *17*(3), 720–742. https://doi.org/10.1108/JHTT-11-2024-0777
29. Huang, M.-H., & Rust, R. T. (2018). Artificial intelligence in service. *Journal of Service Research*, *21*(2), 155–172. https://doi.org/10.1177/1094670517752459
30. Ibrahim, M. Z. F., Mohd Amran, N. W., Mohamad Saber, J., Bahari, K. A., & Johari, N. R. (2024). The impact on customer satisfaction towards robotic service in Indian Muslim restaurants. *Borneo Akademika*, *8*(2), 105–115. https://doi.org/10.24191/BA/v8i2/108305
31. Jaakkola, E. (2020). Designing conceptual articles: Four approaches. *AMS Review*, *10*(1–2), 18–26. https://doi.org/10.1007/s13162-020-00161-0
32. Kim, H. J., Park, J., Kim, M.-J., & Ryu, K. (2013). Does perceived restaurant food healthiness matter? Its influence on value, satisfaction and revisit intentions in restaurant operations in South Korea. *International Journal of Hospitality Management*, *33*, 397–405. https://doi.org/10.1016/j.ijhm.2012.10.010
33. Kim, H., So, K. K. F., & Wirtz, J. (2022). Service robots: Applying social exchange theory to better understand human–robot interactions. *Tourism Management*, *92*, Art. 104537. https://doi.org/10.1016/j.tourman.2022.104537

34. Kim, S. Y., Schmitt, B. H., & Thalmann, N. M. (2019). Eliza in the uncanny valley: Anthropomorphizing consumer robots increases their perceived warmth but decreases liking. *Marketing Letters*, *30*(1), 1–12. https://doi.org/10.1007/s11002-019-09485-9
35. Kock, N. (2015). Common method bias in PLS-SEM: A full collinearity assessment approach. *International Journal of E-Collaboration*, *11*(4), 1–10. https://doi.org/10.4018/ijec.2015100101
36. Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, *28*(1), 227–261. https://doi.org/10.1111/isj.12131
37. Le, T. M., Phan, B. T., Dang, V. T., & Tran, T. T. A. (2024). Factors influencing perceived value and revisit intention among Vietnamese restaurant consumers. *Zbornik Radova Ekonomskog Fakulteta u Rijeci*, *42*(2), 381–410. https://doi.org/10.18045/zbefri.2024.2.8
38. Leíño Calleja, D., Schepers, J., & Nijssen, E. J. (2025). Hybrid human–robot teams in the frontline: Automated social presence and the role of corrective interrogation. *Journal of Service Management*, *36*(4), 578–602. https://doi.org/10.1108/JOSM-11-2023-0470
39. Leite, I., Martinho, C., & Paiva, A. (2013). Social robots for long-term interaction: A survey. *International Journal of Social Robotics*, *5*(2), 291–308. https://doi.org/10.1007/s12369-013-0178-y
40. MacInnis, D. J. (2011). A framework for conceptual contributions in marketing. *Journal of Marketing*, *75*(4), 136–154. https://doi.org/10.1509/jmkg.75.4.136
41. Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. MIT Press.
42. Mende, M., Scott, M. L., van Doorn, J., Grewal, D., & Shanks, I. (2019). Service robots rising: How humanoid robots influence service experiences and elicit compensatory consumer responses. *Journal of Marketing Research*, *56*(4), 535–556. https://doi.org/10.1177/0022243718822827
43. Meuter, M. L., Bitner, M. J., Ostrom, A. L., & Brown, S. W. (2005). Choosing among alternative service delivery modes: An investigation of customer trial of self-service technologies. *Journal of Marketing*, *69*(2), 61–83. https://doi.org/10.1509/jmkg.69.2.61.60759
44. Mori, M., MacDorman, K. F., & Kageki, N. (2012). The uncanny valley [From the field]. *IEEE Robotics & Automation Magazine*, *19*(2), 98–100. https://doi.org/10.1109/MRA.2012.2192811
45. Namkung, Y., & Jang, S. (2007). Does food quality really matter in restaurants? Its impact on customer satisfaction and behavioral intentions. *Journal of Hospitality & Tourism Research*, *31*(3), 387–409. https://doi.org/10.1177/1096348007299924
46. Oliver, R. L. (1980). A cognitive model of the antecedents and consequences of satisfaction decisions. *Journal of Marketing Research*, *17*(4), 460–469. https://doi.org/10.1177/002224378001700405
47. Oliver, R. L. (1999). Whence consumer loyalty? *Journal of Marketing*, *63*(Special Issue), 33–44. https://doi.org/10.1177/00222429990634s105
48. Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879
49. Premathilake, G. W., Li, H., Li, C., Liu, Y., & Han, S. (2025). Understanding the effect of anthropomorphic features of humanoid social robots on user satisfaction: A stimulus-organism-response approach. *Industrial Management & Data Systems*, *125*(2), 768–796. https://doi.org/10.1108/IMDS-10-2023-0781
50. Qian, Y., & Wan, X. (2024). Influence of robot anthropomorphism on consumer attitudes toward restaurants and service providers. *International Journal of Hospitality Management*, *123*, Art. 103939. https://doi.org/10.1016/j.ijhm.2024.103939
51. Rana, N. P., Begum, N., Faisal, M. N., & Mishra, A. (2025). Customer experiences with service robots in hotels: A review and research agenda. *Journal of Hospitality Marketing & Management*, *34*(2), 145–174. https://doi.org/10.1080/19368623.2024.2403640
52. Sarstedt, M., Hair, J. F., Cheah, J.-H., Becker, J.-M., & Ringle, C. M. (2019). How to specify, estimate, and validate higher-order constructs in PLS-SEM. *Australasian Marketing Journal*, *27*(3), 197–211. https://doi.org/10.1016/j.ausmj.2019.05.003
53. Seo, K. H., & Lee, J. H. (2021). The emergence of service robots at restaurants: Integrating trust, perceived risk, and satisfaction. *Sustainability*, *13*(8), Art. 4431. https://doi.org/10.3390/su13084431
54. Seo, K. H., & Lee, J. H. (2025). The impact of service quality on perceived value, image, satisfaction, and revisit intention in robotic restaurants for sustainability. *Sustainability*, *17*(16), Art. 7422. https://doi.org/10.3390/su17167422

55. Sharma, V., Kapse, M., Poulose, J., & Mahajan, Y. (2023). Robotic dining delight: Unravelling the key factors driving customer satisfaction in service robot restaurants using PLS-SEM and ML. *Cogent Business & Management*, *10*(3), Art. 2281053. https://doi.org/10.1080/23311975.2023.2281053
56. Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J.-H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing*, *53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189
57. Song, B., Zhang, M., & Wu, P. (2022). Driven by technology or sociality? Use intention of service robots in hospitality from the human–robot interaction perspective. *International Journal of Hospitality Management*, *106*, Art. 103278. https://doi.org/10.1016/j.ijhm.2022.103278
58. Vafaei-Zadeh, A., Nikbin, D., Wong, S. L., & Hanifah, H. (2025). Investigating factors influencing AI customer service adoption: An integrated model of stimulus–organism–response (SOR) and task-technology fit (TTF) theory. *Asia Pacific Journal of Marketing and Logistics*, *37*(6), 1465–1502. https://doi.org/10.1108/APJML-05-2024-0570
59. Weng, Z., Huang, Y., & Weng, S. (2026). From code to care: How artificial empathy enhances customer experience in human-robot interaction. *Journal of Business Research*, *206*, Art. 115969. https://doi.org/10.1016/j.jbusres.2026.115969
60. Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: Service robots in the frontline. *Journal of Service Management*, *29*(5), 907–931. https://doi.org/10.1108/JOSM-04-2018-0119
61. Yang, Y., Chi, M., Bi, X., & Xu, Y. (2024). How does the anthropomorphism of service robots impact employees' role service behavior in the workplace? *International Journal of Hospitality Management*, *122*, Art. 103857. https://doi.org/10.1016/j.ijhm.2024.103857
62. Zeithaml, V. A., Berry, L. L., & Parasuraman, A. (1996). The behavioral consequences of service quality. *Journal of Marketing*, *60*(2), 31–46. https://doi.org/10.1177/002224299606000203
63. Zhang, S., Lin, X., Li, X., & Ren, A. (2022). Service robots' anthropomorphism: Dimensions, factors and internal relationships. *Electronic Markets*, *32*(1), 277–295. https://doi.org/10.1007/s12525-022-00527-1
64. Zhang, W., Slade, E. L., & Pantano, E. (2024). Humanlike service robots: A systematic literature review and research agenda. *Psychology & Marketing*, *41*(12), 3157–3181. https://doi.org/10.1002/mar.22099
65. Zhu, T., Xie, L., & Liu, C. (2025). Driving human-robot value co-creation in hospitality: The role of artificial empathy. *International Journal of Hospitality Management*, *126*, Art. 104075. https://doi.org/10.1016/j.ijhm.2024.104075