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Serving The Future: Factors Influencing Consumer Acceptance of Robotic Waiters in Restaurants

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Abstract: This research examines the factors influencing consumer acceptance of robotic waiters in restaurants. As the food service industry increasingly adopts robotic systems, it is essential to comprehend consumer approval for their effective integration. In this study, the Technology Acceptance Model (TAM) is utilized to investigate the key factors influencing consumer acceptance of robot waiters. It examines consumers' evaluations of these robots' usefulness and ease of use, as well as their attitudes and intentions. The findings illustrate the correlation between perceived usefulness, perceived ease of use, and attitude. Regression analysis highlights the significant roles of perceived ease of use and perceived usefulness in shaping attitudes toward technology, with the former having a more pronounced positive impact. However, anticipating future research into the complexities of user perception, particularly the negative correlation between perceived usefulness and attitude, is an exciting prospect for further investigation. This research enhances the understanding of consumer acceptance of robot waiters in restaurants and provides valuable insights for restaurant operators, policymakers, and other stakeholders. By addressing concerns related to technological adoption and customer preferences, this study guides the effective implementation of robot waiters in the restaurant industry, to improve operational efficiency and service quality.

Keywords: *Robotic Waiters, Consumer Acceptance, Technology Acceptance Model (TAM), Perceived Usefulness, Operational Efficiency*

1. Introduction

The restaurant industry has undergone significant operational changes and challenges, particularly in service delivery. As the dining landscape continues to evolve, ongoing research is essential for navigating the challenges and opportunities of technological advancements in the hospitality sector. One potential solution that has gained attention is the incorporation of robotic waiters to assist in food and beverage services (Wan et al., 2019). While this technological advancement has the potential to address some of the industry's challenges, it is essential to grasp the various factors that impact consumer adoption of robotic waiters in restaurants (El-Said & Hajri, 2022). A robot is a programmable and automated system capable of independently executing a specific task within its environment or under partial human control (Berezina et al., 2019). Consequently, restaurants have programmable and automated systems that can serve customers. Different forms of robotics are utilized within the restaurant sector. Lu et al. (2019) reported that a culinary robot is tasked with preparing a variety of dishes, while a reception robot greets patrons at the entrance and escorts them to their tables. Additionally, a server robot takes customer orders and serves dishes at their tables (Eksiri & Kimura, 2015). Moreover, robot waiters, also known as robotic waiters or robot servers, are autonomous or semi-autonomous robots designed to perform various tasks typically carried out by human restaurant waitstaff. For instance, an entirely automated hotpot eatery named Haidilao in China employs robotic chefs and waitstaff. This establishment has been operational since 2018, and multiple humanoid robots shuttle between the kitchen and dining area to attend to the patrons.

The rising number of individuals dining outside their homes has led accommodation and restaurant services to seek innovative methods to cater to a larger clientele (Lee et al., 2018). Robotic restaurants are now commercially available and have seamlessly integrated into our everyday experiences (Berezina et al., 2019). The integration of artificial intelligence (AI) and robotic technologies in the restaurant sector is currently in its early stages, yet it is a rapidly evolving field. More and more businesses are embracing these technologies to improve their operational processes and enhance customer experiences (Berezina et al., 2019).

In the context of Malaysia, AI technologies have been gradually implemented to enable service robots to enhance productivity and efficiency in meeting customer demands. As the number of restaurants adopting this technology grows, understanding the factors driving consumer acceptance becomes increasingly important. This study, conducted within the local context, offers valuable insights for both restaurant operators and policymakers. By investigating the key determinants of consumer acceptance, the research aims to inform strategic decision-making regarding the implementation and optimization of robot waiters in Malaysian restaurants. This knowledge is essential for ensuring the successful integration of robot technologies into the hospitality sector and maximizing the potential benefits for both businesses and consumers.

2. Literature Review

Adoption of Robotics in Service Industries

The utilization of service robots in the hospitality sector and service industries is on the rise as they are capable of improving customer experiences by engaging in social interactions and demonstrating adaptability (Lu et al., 2019). These robots can perform tasks with greater productivity and efficiency than traditional technologies like kiosks or tablets, as they can analyze data and adapt to their environments (Wirtz et al., 2018). Robotic restaurants can attract tech-savvy customers and differentiate themselves from competitors (Ivanov et al., 2017). Furthermore, they help address the restaurant industry's high turnover rates by offering continuous service without the problems of human labor, like illness or faults in service delivery.

Technology Acceptance Model (TAM) Framework

The Technology Acceptance Model (TAM), as proposed by Davis et al. (1989), explains the way individuals adopt and utilize new technology. This model emphasizes the significance of attitudes and intentions shaped by perceived benefits. The concept outlined above is frequently employed in the context of human-robot interaction within the hospitality industry (Abou-Shouk et al., 2021). This framework delineates two primary determinants: perceived usefulness, denoting the belief that technology improves outcomes, and perceived ease of use, reflecting the simplicity of mastering the technology (Davis et al., 1989). According to this framework, perceived usefulness and ease of use exert influence over customers' attitudes toward service robots and their inclination to embrace them within the hospitality sector (Hwang et al., 2020).

Perceived ease of use

Customer perceptions of the usefulness and ease of use of robotic waiters are critical factors in shaping their overall attitudes toward the adoption of these technologies. The ease of use, with which a customer perceives the robotic system as straightforward and intuitive to interact with, can significantly influence their willingness to embrace the technology (Lee et al., 2018). Recent research has investigated the elements that impact how customers view robotic waitstaff, such as trust, interaction, and the level of service provided (Lee et al., 2018). These studies suggest that the perceived usefulness and ease of use of robotic waiters are primary factors in customer attitudes toward their adoption (Ivanov & Webster, 2022).

Perceived usefulness

The perceived usefulness of robotic waiters is a critical factor in determining customer acceptance. Incorporating robotic waiters is more appealing to customers when they view them as advantageous, effective, and able to enhance their dining experience (Lee et al., 2018). Prior research has indicated that the perceived advantages of using robotic waitstaff, such as enhanced service quality, quicker order fulfillment, and the potential to mitigate staffing shortages, can have a positive impact on customers' perceptions of the usefulness (Jang & Lee, 2020). In contrast, the perceived risks associated with the use of robotic waiters, such as concerns about safety or reliability, can negatively impact their perceived usefulness (El-Said & Hajri, 2022). Additionally, the quality of interaction between customers and robotic waiters, as well as the level of trust in the technology, can also shape perceptions of usefulness (Seyitoğlu & Ivanov, 2020).

Attitude

Attitudes are defined differently across disciplines. Attitudes are behaviors expressed verbally, influencing prejudice and discrimination. Sociologically, attitudes indicate an intent to act as a mental position or feeling towards a fact or state. The Theory of Planned Behavior characterizes behavior attitudes as an individual's favorable or unfavorable evaluation of behavior, which influences the probability of them engaging in it (Ajzen,

1991). In tourism, attitudes help tourists make decisions psychologically. However, recent research on environmental behavior and green consumption suggests that attitudes have less influence on behavior compared to subjective norms and perceived behavioral control (Manosuthi et al., 2020). Likewise, attitudes may play a limited role in shaping the intention to visit and revisit robotic restaurants.

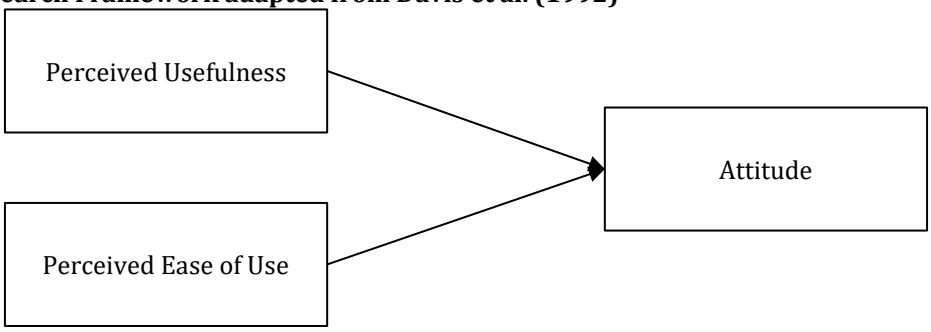
The relationship between perceived ease of use, perceived usefulness, and attitude

The relationship between perceived usefulness, perceived ease of use, and the resulting attitude towards robotic waiters is crucial to discover. The Technology Acceptance Model suggests that both perceived usefulness and perceived ease of use can positively influence an individual's attitude toward the adoption of a new technology (El-Said & Hajri, 2022). Studies have found that perceived usefulness has a stronger influence on customer attitudes toward robotic waiters compared to perceived ease of use (Sung & Jeon, 2020). This indicates that customers may be willing to overlook certain usability challenges if they perceive the robotic waiters as being highly useful in enhancing their dining experience. Additionally, the need for social interaction and the level of innovativeness of customers can also shape their attitudes toward the adoption of robotic waiters (Sung & Jeon, 2020). Additionally, trust and the quality of the robots' output significantly affect customers' perceived usefulness, as does the interaction between the customer and the robot, which has a positive influence on perceived ease of use (Seo & Lee, 2021).

Research Framework (Conceptual/Theoretical)

The conceptual framework has been adapted and refined from previous research, including Davis et al.'s (1989) technology acceptance model, to explicate how individuals utilize and embrace specific technologies. According to the model, an individual's inclinations and motivations to learn and adopt new technology are influenced by the perceived benefits associated with the technology.

Figure 1: Research Framework adapted from Davis et al. (1992)



3. Methodology

The collected data was analyzed using a quantitative research approach in this study. Customers who had previously interacted with humanoid robots in restaurants made up the target population. The research utilized a purposive sampling method. Information was obtained by conducting a survey consisting of queries in Sections A, B, and C. Following data collection, analysis was carried out using the Statistical Package for Social Science software. The main analyses performed involved conducting a descriptive analysis to examine the demographic profile, evaluating reliability, and performing regression analysis to investigate the relationships between the independent and dependent variables.

4. Research Findings

The data regarding the participants' demographics is outlined in Table 1, with a total of 171 individuals included in this study. The breakdown of genders showed that 54.4% of the participants were male, with the remaining 45.6% being female. Among the participants, 21.1% were aged 18–25, most of whom were undergraduate students. The second largest age group was 26-35 years old, accounting for 24.6% of the sample. The age groups of 36-45 years old and 46-55 constituted 28.7% and 25.1% of the participants, respectively. The age group of 55 and above represented only 0.6% of the total respondents. Additionally, 54.4% of the respondents reported being married, while 45.6% reported being single, indicating a relatively balanced

representation of both marital statuses. This balanced distribution provides an opportunity to explore and compare the perspectives or experiences of single and married individuals within the scope of the survey's research questions. The majority of respondents are employed in the private sector, comprising 31.6% of the sample, followed closely by those in public service at 26.3% and business owners at 25.7%. Students make up the smallest category, representing 16.4% of the sample.

Table 1: Demographic Analysis

Category	Demographic	Frequency	Percentage
Gender	Male	93	54.4
	Female	78	45.6
Age	18 - 25	36	21.1
	26 - 35	42	24.6
	36 - 45	49	28.7
	46 - 55	43	25.1
	55 and above	1	0.6
Marital Status	Single	78	45.6
	Married	93	54.4
Occupation	Public Service	45	26.3
	Private Sector	54	31.6
	Own Business	44	25.7
	Student	28	16.4

Correlations Analysis

The analysis presented involved examining the relationships between three variables: Perceived Usefulness, Perceived Ease of Use, and Attitude. These correlations were assessed using Pearson's correlation coefficient, a statistical measure that evaluated the linear relationship between two continuous variables. The strong positive correlation between Perceived Usefulness and Perceived Ease of Use ($r = 0.756$, $p < 0.001$) suggests that an increase in perceived usefulness tends to correspond with an increase in perceived ease of use. The observed significance level ($p < 0.001$) suggests that the examined relationship is statistically significant. Additionally, the correlation between Perceived Usefulness and Attitude ($r = 0.513$, $p < 0.001$) indicates a moderate positive association, signifying that higher perceived usefulness is linked with a more favorable attitude. The correlation is considered to be statistically significant. Additionally, the correlation between Perceived Ease of Use and Attitude ($r = 0.766$, $p < 0.001$) also indicates a strong positive relationship. This suggests a substantial positive correlation, indicating that ease of use is closely linked to a positive attitude. The significance level further validates the strength of this relationship.

Table 2: Correlations Analysis

		Perceived Usefulness	Perceived Ease of Use	Attitude
Perceived Usefulness	Pearson Correlation	1	0.756**	0.513**
	Sig. (2-tailed)		<0.001	<0.001
	N	171	171	171
Perceived Ease of Use	Pearson Correlation	0.756**	1	0.766**
	Sig. (2-tailed)	<0.001		<0.001
	N	171	171	171

Attitude	Pearson Correlation	1	0.756**	0.513**
	Sig. (2-tailed)		<0.001	<0.001
	N	171	171	171

Regression Analysis

The multiple regression analysis investigates the impact of Perceived Usefulness and Perceived Ease of Use on the dependent variable, Attitude. The Model Summary, ANOVA table, and Coefficients collectively offer a thorough comprehension of the relationships among these variables.

Table 3: Regression Analysis

Independent Variables	Unstandardised Coefficients (B)	Standardized Coefficients (Beta)	t-stat	p-value
Constant	1.299	-	6.654	0.000
Perceived Usefulness	-0.138	-0.153	-2.042	0.043
Perceived Ease of Use	0.786	0.067	11.759	0.000
R				0.772
R^2				0.596
Adjusted R^2				0.591
F-test				123.964
Sig.				0.000

Dependent variable: Attitude

The adjusted R^2 value of 0.591 suggests that the findings of this study may apply to other populations. Since the adjusted R^2 is similar to the R^2 value, it can be concluded that there is no evidence of overfitting of the model to the sample (Hair et al., 2006). The regression model demonstrates a high degree of accuracy in fitting the data. The F-test statistic is 123.96, with a p-value of less than 0.001, indicating a strong and statistically significant association between the variables. The positive coefficients of the independent variables indicate a positive relationship between the independent and dependent variables, as shown in the unstandardized coefficients. The effects of the independent variables on the dependent variable are presented in Table 3. The analysis reveals that perceived usefulness (B = -0.153, t = -2.042, p = 0.043) is not a significant predictor of attitude. In contrast, perceived ease of use (B = -0.067, t = -11.76, p = 0.000) significantly predicts attitude toward robot waiters. Overall, the findings underscore the critical roles of perceived ease of use and perceived usefulness in shaping attitudes toward technology, with perceived ease of use having a more substantial positive effect.

Discussion

The findings of this study provide important insights into the determinants shaping consumer attitudes toward robotic waiters in restaurant settings. The correlation analysis reveals a strong interrelationship between perceived usefulness, perceived ease of use, and consumer attitudes, consistent with the Technology Acceptance Model (Lee et al., 2018). The regression analysis further demonstrates that perceived ease of use is a significant predictor of consumer attitudes, whereas perceived usefulness does not show a substantial predictive relationship. This unexpected outcome suggests that consumers may prioritize the ease of use of robotic waiters over their perceived benefits. These findings align with the Technology Acceptance Model, which posits that both perceived ease of use and perceived usefulness influence consumer acceptance and adoption of technology (Taegoo et al., 2008). However, the results challenge the conventional notion that perceived usefulness is the primary factor driving the adoption of new technologies (Brown et al., 2002).

The findings indicate that the design and user interface of robotic waiters should prioritize intuitiveness and simplicity to improve the overall customer experience. This conclusion is consistent with prior research on

service robotics, which emphasizes the critical role of user-friendly interfaces and seamless human-machine interactions in enhancing customer satisfaction (Lee et al., 2018; Kim & Lee, 2014). Additionally, the study underscores the critical role of trust in shaping consumer perceptions of robotic waiters (Seo & Lee, 2021).
This study also highlighted that younger consumers tend to be more receptive to innovative technologies, which may explain the limited impact of perceived usefulness among older respondents. Specifically, the discovery that perceived usefulness does not significantly predict attitudes, especially among respondents aged 36-45 years (Bowen & Morosan, 2018). The comprehensive understanding of how age and individual differences, including innovativeness and technology anxiety, impact perceptions of robotic waiters not only challenges but also expands current theoretical frameworks.

5. Conclusion and Recommendations

This study contributes to the growing literature on technology acceptance in the hospitality sector by examining the factors influencing consumer acceptance of robotic waiters in restaurants. Findings indicate that perceived usefulness, social influence, and trust in technology are key determinants of acceptance, with younger consumers generally more open to robotic innovations. By applying the Technology Acceptance Model (TAM), this research highlights the importance of perceived ease of use and usefulness in shaping consumer attitudes toward robotic waiters. The study offers valuable insights for stakeholders, including restaurant owners, technology developers, and policymakers, emphasizing the need for targeted strategies to enhance consumer trust and satisfaction. In the context of the Malaysian restaurant industry, the findings provide critical guidance for the effective integration of robotic waiters, with potential policy implications for promoting technological advancements while ensuring customer comfort and engagement.

Future research should explore the consumer reception of robotic waiters by analyzing a range of factors, including demographic segments and cultural and socioeconomic variations, to provide a more detailed understanding of consumer behavior. Such investigations will contribute to a deeper comprehension of how diverse factors influence consumer acceptance and inform the development of more effective and tailored robotic technologies. In addition, longitudinal research should be conducted to assess how familiarity and experience with robotic waiters affect acceptance over time. Investigations into service design, particularly the dynamics of human-robot interactions, are also suggested to identify configurations that maximize customer satisfaction. Additionally, future studies should evaluate the impact of technological advancements, such as AI-driven features, on consumer perceptions. Developing robust policy frameworks that address concerns related to safety, data privacy, and employment will be crucial for the seamless integration of robotic waiters. Lastly, economic analyses, including cost-benefit evaluations and labor market assessments, are recommended to inform strategic decision-making in the Malaysian restaurant industry.

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