A new era of technological change in the restaurant industry: focusing on perceived values of robot servers

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Article Info	ABSTRACT
	The objective of this research is to examine the perceived values of robot servers, which include utilitarian and hedonic values, and how this influences willingness to pay more in the restaurant industry. This paper also examined the differences between the two sub-dimensions of perceived value, which are based on the demographic factors of the respondents. This research performed a data analysis based on a sample size of 295 participants, and the results indicated that the two sub-dimensions of perceived value play a crucial role in regard to the formation of willingness to pay more. Furthermore, the results showed that there were differences in perceived value in regard to the demographic factors.

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1. INTRODUCTION

The restaurant sector has recently experienced a growing trend, which includes where robots are employed, in order to maximize the customer experience and enhance operational efficiency [1]. One of the most significant applications of robotics in the foodservice sector is the use of autonomous robot servers. Robots can replace various tasks that are performed by human servers. For example, robots' jobs consist of welcoming clients, showing customers to their tables, taking orders, serving food and drinks, and processing payments [2]. Robots have the advantage of improving the service quality and reducing labor costs via the roles of these types of robots from the perspective of restaurant administration [3]. Consumers in particular tend to prefer contactless services after coronavirus disease 2019 (COVID-19), such as robot services, due to hygiene problems [4]. Robot servers are receiving a lot of attention in academia as well as in industry for these reasons.

Perceived value is an important factor that affects the overall dining experiences of customers in the restaurant industry [5], [6]. This statement is no exception to robot restaurants. According to Hwang *et al.* [7], customers evaluate the overall brand based on the value of the services that are provided by a robot. Chuah *et al.* [8] also suggested that perceived value is one of the factors that determines consumer attitudes in the field of robot restaurants. It is very important in this regard for robotic restaurant managers to provide services that can be perceived as being of high value to the customers. Thus, this study focuses on the importance of the perceived value of robot servers in restaurant management.

The study additionally emphasized the relevance of the demographic factors of the customers in regard to explaining the significance of perceived value, which is unlike the previous research, because the

demographic factors are significant factors that affect customer behavioral intentions [9]. The demographic factors in particular play a critical role in tens of predicting consumer behavior in new technology-based services [10]. Many of the existing studies put a lot of effort into predicting consumer behavior according to demographic factors in the field of new technology-based services. For this reason, this study also seeks to prove the importance and necessity of demographic factors in the field of robotic restaurants.

In summary, the previous empirical research explored the concept of perceived value in various sectors. However, it is meaningful to expand the significance of perceived value in order to encompass robot services in the food service sector. Hence, the objectives of the current study include confirming the reliability and validity of perceived value and examining its effect on willingness to pay more. In addition, the current paper investigated the differences in perceived value with regard to the demographic factors.

2.   METHOD

The current paper addresses the acknowledged research problem by using a hypothetico-deductive method. A systematic theoretical review of each construct was conducted, and all the hypotheses among the constructs in the proposed model were established based on theoretical foundations. The data collection and the quantitative analysis were subsequently performed, and the detailed explanations are provided in the sections below.

2.1. Systematic theoretical review
2.1.1. Perceived value

Perceived value has been a topic of research in regard to identifying how to form behavioral intention in regard to consumer behavior [11], [12]. Perceived value can be defined as "the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given" [13], [14]. The perceived value of customers is essentially determined by the balance between the benefits gained from a product and the cost incurred to purchase it [14]. For example, if customers perceive that the benefits they receive from a robot server in a restaurant exceed their expenses, they will perceive a high value.

It is widely accepted that perceived value includes two sub-dimensions, utilitarian and hedonic values [12], [15]. Utilitarian value (UV) is associated with the functional or practical benefits that a certain product or service provides to consumers [16]. This value is determined by the needs of the consumers to solve a problem or achieve a specific goal [15]. For instance, customers visit a restaurant in order to eat, which is due to being hungry, and this is a typical case of UV. On the other hand, hedonic value (HV) is associated with the emotional or experiential merits that a product or service provides to consumers [16]. This value is also established by the consumer's desire for pleasure and sensory experiences [15]. For example, customers prefer to eat at a restaurant with a beautiful view.

Previous studies also imply the crucial role of perceived value in diverse industries. Kesari and Atulkar [17] proposed a theoretical model to examine the importance of perceived value in the shopping field, and they argued that UV/HV play an essential role in forming customer satisfaction. Additionally, Teng and Wu [6] investigated the role of perceived value in the hospitality industry. They discovered via their data analysis that both UV/HV are factors affecting brand preference. Kertasunjaya et al. [18] also explored how perceived value affects customer satisfaction in restaurant management. They showed that UV/HV is a crucial contraceptive in customer satisfaction. Hwang et al. [12] more recently examined the significance of the perceived value of a robotic coffee shop. They found that UV/HV has a positive influence on memorable brand experience.

2.1.2. The effect of perceived value on willingness to pay more

This study attempted to find the relationship between perceived value and willingness to pay more (WPM). The term WPM means the highest monetary amount that consumers are willing to pay for products in regard to their preferred brand compared to other brands [19]. Perceived value is an essential determinant of consumer behavior, particularly when it comes to WPM [20]. It can be inferred that if restaurant customers perceive the value of using robot servers, they may be willing to pay more when using a restaurant. Empirical studies also support the nexus between perceived value and WPM. For example, Ozturk et al. [21] created a theoretical framework in 2016 to explore the correlation between perceived value and the WPM in booking hotels via mobile devices. Their research revealed that perceived value is an essential predictor in regard to determining whether customers are willing to pay extra money. In addition, a study that was conducted by Chen et al. [22] investigated the importance of perceived value of food delivery platform services, and they indicated that UV/HV affect in regard to enhancing purchase intention. Ghali [23] also developed a theoretical model, which included the causal nexus between perceived value and WPM in the field of organic

foods. The author showed that UV/HV helps to enhance consumers' willingness to buy. Yin and Qiu [24] more recently examined how perceived value affects purchase intention in online shopping platforms, and their data analysis results revealed that UV/HV play an essential role in forming purchase intention. Thus, the hypotheses below are presented.

> H1. UV has a positive impact on WPM.
> H2. HV has a positive impact on WPM.

2.1.3. The differences of perceived value based on the demographic factors

Demographic factors have been employed for a long time in order to extensively identify consumption tendencies in diverse sectors, such as airlines, cutting-edge technology-based services, hotels, and tourism [10]. It is widely accepted that demographic factors are key variables that affect consumers' decision making [25]. Consumers in particular exhibit different behaviors based on their demographic factors in the cutting-edge technology-based services sector. As an example, Hwang *et al.* [10] examined the differences in perceived value, UV/HV, provided by robot services based on demographic factors in the airline industry. The findings showed that there were statistical differences in perceived value according to the consumers' age group and marital/educational status. Furthermore, Hwang *et al.* [26] performed *t*-tests and a one-way analysis of variance (ANOVA) test for identifying whether there were differences in consumer behavior according to demographics in the drone-based foodservice field. Their study proved the differences in the three sub-dimensions of behavioral intentions (i.e., intentions to use, word-of-mouth, and WPM) according to gender, age-group, marital status, and income level. The current paper proposes the hypothesis below, grounded on the empirical studies above.

> H3. There are significant differences in perceived values according to demographic factors.

2.2. Instruments

Multiple items were employed in the scales in order to measure the variables in the proposed hypothetical framework. The items that were borrowed from the existing works were adapted. The measurement of perceived value in the current paper consisted of two sub-dimensions, UV and HV. Three items were selected from Babin *et al.* [15] in order to measure these sub-dimensions. WPM was also evaluated by using three instruments that were taken from the study by Zeithaml *et al.* [27]. A Likert scale, which ranged from strongly disagree to strongly agree, was employed in order to evaluate all the instruments. Modifications were additionally made to the original instruments to make them more suitable for the context of robotic restaurants.

2.3. Data collection

The current research gathered sample data from customers via a data collection company in order to test the postulated hypotheses, and 10 survey experts were recruited for this procedure. The survey sample was selected from M brand, which is a South Korean foodservice franchise where robots provide the services. The respondents were provided with a detailed explanation of the research purpose before completing the survey. The survey experts waited at the entrance of the restaurant, and they approached customers who had received robot services from the restaurant by requesting them to complete the survey. A total of 300 surveys were gathered. However, five questionnaires were excluded from the analysis, because they were identified as multivariate outliers. 295 surveys were consequently used for the final analysis of the data.

3. RESULTS AND DISCUSSION

3.1. Frequency analysis

Among the gathered samples, 125 were male (42.4%), and 170 were female (57.6%). The largest age group, which included 36.6%, was respondents in their 30s (*n*=108), followed by 40s (26.1% and *n*=77). The most samples responded having a bachelor's degree (82.4% and *n*=243). 165 were married (55.9%), and 83 were responded a monthly household income between USD 5k – 6k (28.1%).

3.2. Principal components analysis (PCA)

Table 1 displays the outcomes of the PCA, which assesses the underlying dimensions of perceived values and WPM. The analysis revealed a unidimensional model consisting of two factors, which included UV/HV, and WPM was a unidimensional model. All constructs had an eigenvalue greater than 1.0, and Kaiser-Meyer-Olkin (KMO) values were higher than 0.7. Each construct's Bartlett's test of sphericity was $p < 0.001$, it was also statistically adequate. All factor loadings were also higher than 0.7, the results of PCA for

HV/UV explained 82.559% of the variance, and the PCA for WPM explained 89.805% of the variance. Each construct's Cronbach's alpha value was larger than 0.7, indicating adequate consistency.

Table 1. Results of PCA

Constructs (Mean and SD)	Factor loading	Eigen value	Explained variance	Cronbach's α
Perceived value				
Hedonic value (5.58 and 0.84)		2.587	43.108	0.847
fun.	0.867			
happy.	0.863			
truly a joy	0.853			
Utilitarian value (5.64 and 0.88)		2.367	39.450	0.925
economical.	0.853			
pragmatic.	0.794			
convenient.	0.789			
KMO measure of sampling adequacy=0.861 and Bartlett's test of sphericity ($p < 0.001$)				
Willingness to pay more (5.30 and .99)		2.694	89.805	0.943
I am likely to pay more for this restaurant.	0.960			
It is acceptable to pay more for this restaurant.	0.943			
I am likely to spend extra in order to use this restaurant.	0.939			
KMO measure of sampling adequacy=0.761 and Bartlett's test of sphericity ($p < 0.001$)				

3.3. Multiple linear regression analysis

The outcomes of the regression analysis that were used for examining the postulated causal hypotheses are presented in Table 2. The findings demonstrated that UV (β=0.481 and t=7.396) and HV (β=0.181 and t=2.780) have a positive influence on WPM. As a result, Hypothesis 1 and Hypothesis 2 were supported.

Table 2. Results of regression: The effect of perceived value on WPM

	Predictors		Outcome	β	t-value	Results
H1	Utilitarian value	→	Willingness to pay more	0.481	7.396[*]	Accepted
H2	Hedonic value			0.181	2.780[*]	Accepted

Notes: [*]$p < 0.05$, F-value=92.067, and the adjusted R^2=0.383

3.4. Differences analysis

Table 3 displays the results of the t-tests and the one-way ANOVA for testing the postulated hypothesis associated with demographic differences. The results indicated that there was a significant difference in the means of the UV/HV between the males and females, with the females showing higher means for both. The results also revealed a significant difference in the mean of HV based on age, with the respondents in their 50s reporting a higher mean compared to the other age groups. There was additionally a significant difference in the means of UV/HV according to the education level. The respondents with a high school diploma specifically had a higher mean for UV, whereas respondents with an associate's degree had a higher mean for HV. Finally, there was a difference in the mean of HV based on the monthly income level, and the group that earned less than US$3,000 per month reported a higher mean for HV.

3.6. Discussion
3.6.1. Theoretical implications

The present study confirms the reliability and validity of perceived value, and it identifies its effects on WPM in the context of robotic restaurants. The study focuses on the perceived values of service robots in the food service sector, and it adopted two sub-dimensions, which include UV/HV. The questionnaire was designed based on the previous research [15] in order to measure these dimensions. The principal components analysis was conducted in order to confirm their reliability and validity. The study attempted to find the nexus between perceived values and WPM. The results of the regression indicate that both UV/HV have a statistically significant effect on WPM, and UV showed a higher coefficient than HV. This finding is consistent with Ghali's [23] study on organic food consumption, and it is the first finding in the robotic restaurant context.

Hwang et al. [10], in contrast, identified the nexus between perceived value and intentions to use robot services at airports, and the result of their findings revealed that HV showed a higher coefficient than

UV. Airport service robots provide non-monetary services, such as shuttle services, directions, and answers to the questions of the travelers, and they also assist with scanning tickets and luggage-tags [28]. Thus, it may result in the HV showing a greater coefficient than the UV. Robot servers provide menus that are monetarily purchased in the restaurant industry, so it would result in the UV showing a higher coefficient than the HV.

In addition, the current study investigated differences in the perceived values of robotic restaurants according to the demographics of the customers for the first time. This research performed a t-test and a one-way ANOVA in order to discover these types of differences. It found the differences in HV/UV per the four demographic characteristics. On the other hand, the current research could not capture the differences in HV/UV per marital status, unlike the expected hypothesis earlier. The existing study showed that married travelers evaluated greater the perceived value of airport service robots than singles [10]. Married tourists travel with their spouses and/or children and bring more luggage compared to unmarried travelers, so they would perceive that robot services at airports are helpful and joyful.

Table 3. Results of the *t*-tests and one-way ANOVA

Gender	Man		Woman		*t*-value	*p*-value
Utilitarian value	5.51		5.73		2.094	0.037*
Hedonic value	5.47		5.67		1.976	0.049*
Age-group	20 - 29	30 - 39	40 - 49	Higher than 50	*F*-value	*p*-value
Utilitarian value	5.64	5.56^a	5.60	5.86^a	1.379	0.249
Hedonic value	5.67	5.42^a	5.56^b	5.87^{ab}	3.472	0.017*
Educational status	High school	Community college	University	Graduate school	*F*-value	*p*-value
Utilitarian value	6.20^a	5.97^{bc}	5.60^b	5.43^{ac}	2.950	0.033*
Hedonic value	6.04	6.12^{ab}	5.52^a	5.47^b	5.199	0.002*
Marital status	Single	Married	Etc. (widow/widower)		*F*-value	*p*-value
Utilitarian value	5.57	5.68	7.00		1.753	0.175
Hedonic value	5.50	5.64	7.00		2.362	0.096
Monthly income (USD)	Less than $3,000	$3,001 ~ 4,000	$4,001 ~ 5,000	$5,001 ~ 6,000	$6,001 ~ 7,000	More than $7,000	*F*-value	*p*-value
Utilitarian value	6.11^a	5.87	5.72	5.46^a	5.66	5.67	1.505	0.188
Hedonic value	6.40^{abcd}	5.76	5.73^{ae}	5.40^{be}	5.56^c	5.60^d	2.981	0.012*

Notes: *$p < 0.05$ and the superscripts indicate the results of the least significant difference in post-hoc analysis.

3.6.2. Practical suggestions

The UV of robot services at restaurants played a crucial role in regard to forming the WPM of the customers. The managers should continuously develop robot services that provide UV in addition to basic functions. For example, robot servers can take the coats or bags of the customers and provide storage services during mealtimes. Robots are also able to explain information about menus via their dialogue system and display screen when customers request an explanation about a menu. The robots' screen can show various types of information, such as introducing the chef, the origin of the main ingredients, cooking methods, and recommended pairing menus with a voice explanation.

The HV of robot services positively influenced the WPM of restaurant customers. The managers can enhance the HV for customers by incorporating humorous and funny dialogue systems into their service robots. For example, the M brand restaurant where the data was collected for this study provides telecommunications company membership benefits. Robot servers can say things like, "Sir, I have a secret to tell you. If you have a K telecom membership, I can give you a 20% discount, so do not worry about the cost and order freely. Just do not tell the owner that I told you this, okay?" It is suggested that creating a sense of fun via these types of witty conversations with the service robots can increase the HV for customers.

Lastly, the demographic factors of the target customers should be taken into account when promoting a robotic restaurant. This study suggests that the lower-income level of group would be a more appropriate target customer than the upper-class group. Thus, using robots in casual dining would be adequate rather than in high-priced restaurants. It also implies that female customers would be an adequate target rather than male customers, so robotic restaurants should mainly develop menus that appeal to females. In addition, the restaurant managers can direct indirect advertising strategies, such as product placement marketing (PPL) in social media channels to target females.

4. CONCLUSION

In summary, this study addressed the following research questions. i) Can perceived values, UV and HV, explain the formation of WPM for robotic restaurants? ii) Are there significant differences in perceived values per the demographic factors? This study presents empirical findings of the causal relationships between perceived values and WPM by using a regression analysis. It also shows differences in perceived

values per gender, age group, educational status, and monthly income level. It also examines the causal nexus between perceived values and WPM in robotic restaurants. Furthermore, it holds significant importance because it explains the factors of robotic restaurant users based on demographic factors. First, the generalization of these results might be limited due to the fact that the study only used samples from South Korea. The future study can consider intercultural differences as a moderating variable to address this issue. Second, the study's reliance on a single survey might cause some measurement bias, so it is recommended that future research consider a sample gathering methodology that minimizes such bias. Third, the current study overlooked the social value of using robot services. The future research should consider social and other values in addition to UV/HV. Fourth, the current research only aims to adopt the concept of WPM as an outcome of perceived value. It is crucial to examine the antecedents of customers' revisit and viral behaviors from the perspective of loyalty marketing for retaining restaurant customers. It can be studied in conjunction with social value, which was previously suggested. Fifth, a recommendation suggests that it include behavioral factors in future investigations, because the current study solely concentrated on the demographic factors of the customers. For instance, future research can consider the dining-out category, frequency, or spending. As behavioral factors. Lastly, this study overlooked the negative factors, such as perceived risks. The future research should consider the concept of perceived risks as predictors of customer behaviors or moderators between values and behaviors.

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C : **C**onceptualization	I : **I**nvestigation	Vi : **Vi**sualization
M : **M**ethodology	R : **R**esources	Su : **Su**pervision
So : **So**ftware	D : **D**ata Curation	P : **P**roject administration
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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY

The author(s) has(have) no permission to share the data.

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