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To cite this article: Ja Young (Jacey) Choe, Jinkyung Jenny Kim & Jinsoo Hwang (2022) Innovative robotic restaurants in Korea: merging a technology acceptance model and theory of planned behaviour, Asian Journal of Technology Innovation, 30:2, 466-489, DOI: [10.1080/19761597.2021.2005466](https://doi.org/10.1080/19761597.2021.2005466)

To link to this article: <https://doi.org/10.1080/19761597.2021.2005466>

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Innovative robotic restaurants in Korea: merging a technology acceptance model and theory of planned behaviour

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ABSTRACT

This study was designed in order to examine how to form behavioural intentions using the technology acceptance model (TAM) and the theory of planned behavior (TPB) in the context of robotic restaurants. In particular, this research proposed that perceived ease of use positively affects perceived usefulness, which thereby exerts a positive influence on attitude. In addition, subjective norm was hypothesised in order to facilitate the enhancement of attitude and personal norm. Lastly, attitude, subjective norm, perceived behavioural control, and personal norm were proposed to play important roles in the formation of behavioural intentions. The data was collected from 416 respondents in South Korea. The data analysis results showed that all the hypotheses within the model that merged the TAM and TPB were statistically supported.

KEYWORDS

Robotic restaurant; technology acceptance model; theory of planned behaviour; personal norm; behavioral intentions

1. Introduction

A *robot* is defined as a ‘programmable and automated system that can perform an intended task in its environment independently or with partial control from a human’ (Berezina et al., 2019, p. 194). Therefore, robotic restaurants can be referred to as restaurants that have programmable and automated systems that can provide services to the diners. Diverse types of robots are used in the restaurant industry. For example, a cook robot is responsible for cooking different types of dishes, and a host robot is in charge of welcoming the customers to the reception area and leading them to the tables (Lu et al., 2019). A waiter robot takes orders from the customers and delivers the dishes to the tables (Eksiri & Kimura, 2015). Previously, these robots existed only in our imagination, and they were considered something that we may only see in robot laboratories (Yu et al., 2012). However, the current robotic restaurants have been commercialised and have become a reality in our daily lives (Berezina et al., 2019; Leung & Loo, 2020). For example, a fully automated hotpot restaurant in China that is called *Haidilao* is staffed by robot chefs and waiters, has been open since 2018,

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and several humanoid robots move back and forth between the kitchen and dining hall in order to serve the customers. Several monitors are automatically updated inside the kitchen for efficient cooking and inventory management (Wang et al., 2019). In South Korea, LG Electronics developed *Cloi ServeBot* to deliver food to the diners (Cho, 2020). The company also developed *Cloi Chefbot*, which is a robot that can cook and serve noodles in family-type buffet restaurants in Korea. Due to the introduction of the Chef robot, the human staff can concentrate on their customers in order to provide more attention and valuable experiences (Malewar, 2019).

Despite the fact that robotic restaurants have been developing rapidly in order to cater to the needs of customers in the current industry (Berezina et al., 2019; Intarakumnerd et al., 2015), the use and application of robotic restaurants remains in an early stage. In academia, among the recent topics about robots or robotics in the hospitality and tourism industry, the most popular topic is related to the benefits and challenges of robotics, which include the use of artificial intelligence (AI) (Cain et al., 2019; Ivanov et al., 2017). Other interesting topics include guest perceptions and the satisfaction with robots (Tussyadiah & Park, 2018; Zhong & Verma, 2019) and the legal and ethical issues of robotics and AI services (Huang & Rust, 2018; Morgan & Pritchard, 2019). Despite this burgeoning research on robotics in the hospitality and tourism industry, the limited academic effort has been exerted that is based on the existing theories in order to psychologically understand the customers' behavioural intention to use robotic restaurants. Without a clear understanding of the drivers in regards to the robotic restaurants usage from a consumer perspective, the restaurants industry may face difficulties attracting diners and may lose their competitiveness in the market. Thus, we decided to follow the widely accepted theories in order to understand the customers' intention to use robotic restaurants, which included the technology acceptance model (TAM) and the theory of planned behavior (TPB).

There are several previous studies that support the better exploratory power with the integration of the TAM and TBP (Yu et al., 2018). However, neither the TAM or TPB by itself is enough to provide a superior explanation of the consumers' behavioural prediction (Chen et al., 2007). There are two important individual perceptions of technology usage in the TAM, which include perceived ease of use and perceived usefulness, but the model has limitations, because it does not account for the social influence or the availability of resources with the individuals' adoption of new technology (Chen & Lu, 2015). In the context of robotic restaurants, diners might not only be motivated to create a positive attitude toward robotic restaurants from perceived ease of use and perceived usefulness, but they might also be prompted by others' preferences regarding the usage of robotic restaurants and an individual's availability of external resources. Either the TAM or TPB by itself cannot provide a comprehensive picture in order to understand the consumers' intention to use robotic restaurants. Therefore, the research objective of this study is to fill the research gap by combining the TAM and TPB into a comprehensive research model in order to predict the consumers' intention to use a robot restaurant.

This study was conducted in Korea, which is a place where the robot industry has continued to develop in recent years. The sales volume of service robots in Korea is growing steadily at an average annual rate of 12.3%, which ranged from 356,500,000,000 KRW (approximately USD 300,000,000) in 2014 to 635,800,000,000 KRW (approximately

USD 534,000,000) in 2019. This growth rate is expected to increase during the COVID-19 pandemic since the consumers prefer contactless restaurant services (KIRIA, 2019). In addition, the Korean government has been supportive of the robot industry. The Intelligent Robot Development and Promotion Law was enacted in 2008, so the relevant ministries must establish a specific plan every five years in order to promote the robot industry and prepare an annual action plan. The plan includes strategies for the development and promotion of robots in restaurants (Ministry of Trade, Industry, and Energy, 2021). The robot restaurant industry in Korea has several opportunities for growth, because the minimum wage continues to increase, consumers prefer contactless service under the pandemic, the number of small-scale start-up restaurants that need to save labour costs has increased, and the population is aging (KIRIA, 2020). With this background, understanding the customers' intention to use robotic restaurants based on the TAM and TPB in the context of Korea can be an interesting case study.

2. Literature review and hypothesis development

2.1. Robotic restaurant services

The positive consequences of adopting robotic restaurants may include the following aspects. First, robotic restaurants can attract tech-savvy customers who are particularly interested in using new technology in their daily lives (Ivanov et al., 2017). The younger generations who are technology neophiliacs are determined to have a favourable attitude toward robots in restaurants (Eksiri & Kimura, 2015). Thus, robotic restaurants can be differentiated from their competitors. Second, the restaurant industry is considerably known to have a higher turnover rate compared with other industries (Murphy et al., 2009). This problem can be solved by robotic restaurants, because robots do not get sick, take vacation leaves, or complain like humans do (Berezina et al., 2019). Third, robots can provide consistent quality services to the customers (Huang & Rust, 2018; Lee, 2011). For example, staff members can make occasional mistakes, such as delivering a dish to the wrong table. However, robots will not confuse table numbers.

The early versions of robots in restaurants were not perfect in many ways (Eksiri & Kimura, 2015; Mishraa et al., 2018). If the staff determined that they would use a robot, the staff would then place the dishes on the robot tray and enter the table number into the robot. The robot moved to the table using the robot trail, which is specially designed for the robots. Lastly, the staff or the customers picked up the food from the robot tray to the customers' tables (Eksiri & Kimura, 2015). In summary, the early versions of the robots are considered to be nothing more than machines that simply carry dishes back and forth following designated lines. Eksiri and Kimura (2015) stated that the extent that the customers and the staff perceive the ease of use and usefulness of robots is the most important feature that these machines need to possess.

The current robots and the automated systems in restaurants have significantly improved compared with the early types of robots in restaurants. Robotic restaurants use robots either at the back or the front of the house (Berezina et al., 2019). At the back of the house, the majority of the robots function as kitchen assistants. Some robots are even involved in the cooking processes, which fully depends on the recipes.

At the front of the house, the majority of the robots work as service robots to welcome customers, guide them to their tables, recommend food, take orders, bring the food to the tables, and make the customers happy. These robots move freely around the restaurant without installed lines, and they are able to stop if an obstacle is present. Some service robots have anthropomorphic features that enable face-to-face interaction, which is similar to humans (Murphy et al., 2017).

There are currently only a few studies that examine the consumers' perception or attitude toward robotic restaurants (Chuah et al., 2021; Hwang et al., 2020; Seyitoğlu & Ivanov, 2020a). For example, Seyitoğlu and Ivanov (2020a) analyzed the customers' robotic restaurant experience based on their online reviews by conducting a thematic content analysis. They found that many travellers have positive evaluations about robotic restaurants, which is mainly due to the robotic restaurants being attractive places for kids and providing unique and new experiences for them. On the other hand, many customers perceived a high level of deficiencies in regards to the robots, because they are not as agile or responsive as humans staff, which results in inconvenience (Seyitoğlu & Ivanov, 2020a).

Hwang et al. (2020) focused on the role of motivating consumer innovativeness in robotic restaurants. They proved that functionally, hedonically, and cognitively motivated consumer innovativeness positively influenced the consumers' overall image of robotic restaurants. Similarly, Chuah et al. (2021) investigated the effect of multi-dimensional value on attitude toward robotic restaurants and willingness to use and pay more for robotic restaurants. In their study, the consumers' attitudes toward the robotic restaurants were affected by various aspects of the consumer values, such as functional, emotional, social, epistemic, co-creation, and conditional.

Compared to the news media, industry reports and individual blogs post new updates about robotic restaurant services, so the academic hospitality literature about this topic is relatively limited due to robotic restaurants still being new and developing. To the best of our knowledge, the manner of increasing customers' behavioural intention to use robotics restaurants based on the integrated TAM and TPB model has yet to be substantially documented.

2.2. TAM

The TAM was introduced by Davis (1989). This model is one of the most popular research paradigms that has been adopted by scholars in order to explain the individuals' acceptance of a new technology (Scherer et al., 2019). The TAM emphasises how the attributes of a new technology influence the users' perception, which thereby enable them to eventually use this type of technology (Ham et al., 2008; Huang et al., 2013; Venkatesh & Davis, 2000).

The TAM has been applied in a wide variety of technological contexts, and it is validated as a proper model in order to explain the individuals' intention to accept new technologies. In particular, the TAM has been used to explain diverse consumer behaviours in the hospitality and tourism field. For example, the TAM was frequently applied in order to investigate the intention to use hotel websites or online travel bookings (Järveläinen, 2007; Jeong et al., 2003; Kamarulzaman, 2007). Scholars have attempted to find out about new technology adoption based on the TAM, such as mobile tourism-based

apps (Chang et al., 2016; Peres et al., 2011), 3D virtual reality (Huang et al., 2013), and hotel biometric systems (Morosan, 2012).

Other than the TAM, theories, such as the Unified Theory of Acceptance and the Use of Technology (UTAUT) have been suggested in order to explain the acceptance of a new technology (Venkatesh et al., 2003; Venkatesh et al., 2012). The UTAUT and UTAUT2 have powerful predictive abilities to explain behavioural intention (Venkatesh et al., 2012), but the models only focus on the direct effects of the antecedents on behavioural intention, which don't show the role of attitude. Meanwhile, the TAM has been popularly applied in the academia over the last few decades, because it is a well-established, robust, and parsimonious model that is used in order to predict the user acceptance of a technology (Rondan-Cataluña et al., 2015). In addition, the previous studies justify the idea of integrating the TAM and TPB (Choe et al., 2021; Yu et al., 2018). Therefore, the TAM was applied in the current study as opposed to other technology acceptance-related theories.

In the TAM, perceived ease of use and usefulness are the two key attributes that have been proposed that affect the users' new technology acceptance. Perceived ease of use is defined as the degree that individuals believe using a particular technology will be free from effort (Davis, 1989, p. 320). Given that effort is a finite resource that a person can allocate diversely, technology that is easier to use among the various options is more likely to be accepted by the consumers. Perceived ease of use in the current study is referred to as the degree that the customers believe using robotic restaurants will be easy.

Davis (1989) defined perceived usefulness as the degree that the consumers believe using a particular technology will improve their work. The individuals are likely to accept a new technology if they consider using a certain technology as being beneficial in order to achieve certain goals and perform their jobs (Yang, 2017). The diners' goal at restaurants is to receive high-quality service without any problems. Therefore, perceived usefulness in our study refers to the degree that the diners believe using robotic restaurants will improve their service quality.

In the TAM, the perceived ease of use and perceived usefulness are proposed in order to influence the consumers' attitude toward the use of technology that further influences their behavioural intentions (Zahid et al., 2010). Morosan (2012) utilised the TAM in order to explain the customers' acceptance of biometric systems in the hotel industry, which they found that the TAM is an appropriate theoretical framework. If the hotel guests perceived that using biometric systems would improve the quality and effectiveness of their stay and are easy to use in hotels, they would form a positive attitude toward the technology. Scherer et al. (2019) synthesised 124 correlation matrices from 114 empirical TAM studies, and they found that perceived usefulness and perceived ease of use significantly predicted a positive attitude toward technology.

The previous studies demonstrated that perceived ease of use has a positively significant direct effect on perceived usefulness and attitude toward technology (Davis, 1989; Herrero & San Martín, 2012; Park et al., 2014; Scherer et al., 2019; Zahid et al., 2010). Porter and Donthu (2006) applied the TAM in order to determine the Internet usage of consumers, and they confirmed that perceived ease of use positively affects perceived usefulness and attitude toward Internet usage. In the hospitality literature, Park et al.

(2014) confirmed the positive relationships among perceived ease of use, perceived usefulness, and attitude toward intranet use in quick service restaurants.

One recent study investigated the factors that influence the consumers' behaviours toward robotic restaurants in Korea (Seo & Lee, 2021). The respondents imagined themselves staying overnight at a business hotel in Seoul, Korea via a scenario-based online survey, and they visited the hotels' robotic restaurant where the robot cook prepares the dishes and the service robot delivers the food to the tables. It was discovered that perceived ease of use was positively related to perceived usefulness. However, the constructs for the TPB were not included in their study (Seo & Lee, 2021).

The previous studies also showed that perceived usefulness influences attitude toward a new technology (Chang et al., 2016; Davis, 1989; Sahli & Legohérel, 2016). Sahli and Legohérel (2016) studied the potential tourists' acceptance of the online booking of tourism products. They found that when people perceive tourism websites as considerably useful, they show a positive attitude toward the online tourism product websites. Chang et al. (2016) proposed a research model based on the TAM and TPB, and they found that perceived ease of use and perceived usefulness have a significant positive impact on attitude toward medical travel apps.

Eksiri and Kimura (2015) described the development process of service robots tested in a real restaurant in Thailand. Their findings indicated that some customers argue that robots are obstacles that occasionally cause difficulty for the customers to walk into a restaurant. In general, when they perceived that the service robots are not useful, their overall evaluation toward these robots is negative (Eksiri & Kimura, 2015). Discussions in the previous literature indicated the reasonableness of proposing the following hypotheses.

Hypothesis 1: Perceived ease of use will have a positive influence on perceived usefulness.

Hypothesis 2: Perceived ease of use will have a positive influence on the attitude toward robot restaurants.

Hypothesis 3: Perceived usefulness will have a positive influence on the attitude toward robot restaurants.

2.3. TPB

The TPB and TAM were chosen in our study for the development of the research model given that the focus of the current study is mainly on the psychological aspects of the individual customers. The TPB was applied in order to examine a wide range of consumer behaviours, and it successfully explained the consumer behavioural intentions (Ajzen, 1991). Moreover, the TPB is known to be an appropriate theory in order to explain and predict volitional behaviours, such as using new technology (de Graaf et al., 2019; Venkatesh & Brown, 2001).

Three factors determine behavioural intention in the TPB (Ajzen, 1991). The first factor is attitude. Attitude is defined as 'an individual's propensity to evaluate a particular entity with some degree of favorability or unfavorability' (Eagly & Chaiken, 2007, p. 583). Entity can be anything, which includes places, issues, ideology, durable goods, and services (Priester et al., 2004). Thus, the customers may have a certain attitude

toward robotic restaurants. In the current study, attitude toward robotic restaurants refers to the customers' propensity in order to evaluate these restaurants with some degree of favour or disfavour.

Second, subjective norm is a persons' beliefs regarding a significant other's opinions and judgments (Ajzen, 1991). Subjective norm is a measure of social compliance, which is due to the fact that people think a person should or should not perform a given action influences the person (Piçarra et al., 2016). The previous studies showed that social influences or social pressure are an important construct in order to investigate the acceptance of new technologies (Lee et al., 2016; Schepers & Wetzels, 2007). In the present study, subjective norm refers to the customers' perception that the majority of the people who are important to them think they should use robotic restaurants.

Third, the availability of personal or material resources can influence people to perform certain behaviours (Piçarra et al., 2016). Perceived behavioural control is how consumers perceive the availability of resources in order to perform tasks. Chaulagain et al. (2021) explained that the individuals' perceptions of having control over the external resources, such as time and knowledge in order to perform a behaviour play an important role with engaging in that specific behaviour.

After conducting a thorough literature review about studies that integrated the TAM and TPB, we found that the predictors of TAM, which include perceived ease of use and perceived usefulness, are linked to attitude, but they are not linked to subjective norm and perceived behavioural control in the TPB (Arora & Sahney, 2018; Cheunkamon et al., 2020; Choe et al., 2021). Attitude is completely an individuals' own judgment, which is based on their evaluation of an entity. On the contrary, subjective norm is an individual's perception of other people's judgment or preference of an object. Similarly, perceived behavioural control is driven by external status to some extent. Rondan-Cataluña et al. (2015) also stated that linking social norm in the TAM is not theoretically certain. Therefore, the links between the two key antecedents of the TAM and subjective norm and perceived behavioural control are not connected in the present study.

On the other hand, even some studies that adopted the TPB do not investigate the relationships between subjective norm and attitude, and the recent studies show evidence that subjective norm and attitude are significantly related to each other in regards to influencing behavioural intention (Lee et al., 2016; Shin & Hancer, 2016). Shin and Hancer (2016) adopted the TPB in order to investigate the US consumers' intention to purchase local food, and they demonstrated that subjective norm positively influences attitude toward local food.

Lee et al. (2016) explored the motivations behind social media users in order to show their endorsement online, and they demonstrated that subjective norm is positively associated with the users' attitude toward online endorsement on social media. On the basis of the preceding discussion, a reasonable assumption is that when there is social pressure where using a robotic restaurant is viewed positively by the reference groups, the individuals are likely to form a positive attitude about using a robotic restaurant. Thus, the following hypothesis is proposed.

Hypothesis 4: Subjective norm will have a positive influence on the attitude toward robot restaurants.

Personal norm refers to 'feelings of an individuals' obligation to perform a specific behaviour' (Schwartz, 1977; Schwartz & Howard, 1981). Moreover, personal norm is differentiated from social norm or subjective norm (Roos & Hahn, 2019). The effect of personal norm is frequently investigated in the pro-environmental behavioural studies, because the more people that have a high degree of personal norm, the more they are likely to be involved in green consumption (Cvelbar et al., 2017). However, personal norm is also an important concept to study in the technology literature (Huijts et al., 2012; Kim & Hwang, 2020; Nordlund et al., 2016). The current study defines personal norm as the feeling of a customers' obligation to use a robotic restaurant.

Several of the previous studies that applied the extended TPB confirmed that subjective norm has an impact on personal norm (Han & Hyun, 2017; Kim & Hwang, 2020; Liu et al., 2017). Liu et al. (2017) confirmed that if there is social pressure to encourage an individual to reduce car-based transport, the individuals then have considerable personal obligations to engage in reducing car-based transport. Han and Hyun (2017) also applied the TPB into their model, and they proved that subjective norms positively influence personal norms, which thereby confirms that social pressure to engage in sustainable environmental behaviour will lead individuals to feel obligated to engage in this type of behaviour. In the technology service literature, Kim and Hwang (2020) recently showed that subjective norm has an impact on personal norm, which thereby eventually leads to behavioural intention in the context of drone food delivery services.

The previous discussion indicates that whether or not the potential diners will carefully evaluate their behaviour, which includes using robotic restaurants, is expected to be encouraged by their families and friends and will likely lead to the customers experiencing personal pressure to visit robotic restaurants. Thus, the following hypothesis is proposed.

Hypothesis 5: Subjective norm will have a positive influence on personal norm.

Intention is the central element of the TPB. Piçarra et al. (2016) explained that intention is a sign of the effort individuals are willing to exert in order to perform a certain behaviour. If people intend to take certain actions, they then have planning and an appropriate level of confidence in the ability to perform these types of actions (Perugini & Bagozzi, 2004). Adopting robotic restaurants have productivity potential and numerous benefits, so adopting them is only beneficial as long as the customers want to use the products. Therefore, the extent that the customers' behavioural intention to use robotic restaurants is affected by the antecedents should be understood.

The previous studies showed sufficient evidence that attitude, subjective norm, and perceived behavioural control positively affect behavioural intention (Alam & Sayuti, 2011; Cheon et al., 2012). Alam and Sayuti (2011) proved that attitude, subjective norm, and perceived behavioural control are significant factors that affect the consumers' halal food purchase intention. Cheon et al. (2012) examined the current state of the US college students' perceptions of mobile learning. The results indicated that attitude, subjective norm, and behavioural control positively affect the students' intention to adopt mobile learning.

Moreover, the majority of the empirical findings in the previous studies that integrated the TAM and TPB or extended the TPB confirmed that a high level of attitude, subjective

norm, and behavioural control will increase the consumers' intention to use or purchase products (Amaro & Duarte, 2015; Cheng & Cho, 2011; Kim & Hwang, 2020; Lu et al., 2009). Amaro and Duarte (2015) found positive relationships between attitude and behavioural control on behavioural intention to purchase travel products online. The aforementioned study integrated the constructs from the well-established theories of consumer behaviour, which include the TPB and TAM, but did not include key variables, such as perceived ease of use, perceived usefulness in the TAM, and subjective norm in the TPB regarding travel online shopping.

In order to examine the elements that affect the employees' behavioural intention for innovative information and communication technologies, Cheng and Cho (2011) used the TAM and TPB and confirmed that attitude, subjective norm, and perceived behavioural control affect the employees' intention to use information systems. Lu et al. (2009) explored the Chinese users' acceptance of instant messaging based on the TPB and TAM. They demonstrated that the users' attitude, subjective norm, and perceived behavioural control positively affect behavioural intention to use instant messaging. In their model, the TAM was extended in order to include new variables, such as perceived enjoyment and concentration, but they did not investigate the relationship between subjective and personal norms. The following hypotheses are proposed on the basis of the preceding discussion.

Hypothesis 6: Attitude toward robot restaurants will have a positive influence on the behavioural intention to use these restaurants.

Hypothesis 7: Subjective norm will have a positive influence on the behavioral intention to use robot restaurants.

Hypothesis 8: Perceived behavioral control will have a positive influence on the behavioral intention to use robot restaurants.

The previous studies indicated that personal norm is positively associated with the individuals' behavioural intention (Harland et al., 1999; Kim & Hwang, 2020; Klöckner, 2013; Shin et al., 2018). Shin et al. (2018) applied the TPB, and they confirmed that consumers who have a personal obligation toward choosing organic menu items were found to be likely to choose organic menu items. Harland et al. (1999) proved that other than the existing three variables, which included attitude, subjective norm, and perceived behavioural control, personal norm should be included in the TPB model in order to contribute to the explanation of the intention to use. The positive relationship between personal norm and behavioural intention was also confirmed using a meta-analytical structural equation modelling approach (Klöckner, 2013).

The recent studies showed that personal norm is also a critical variable in order to test its effects in the technology adoption model. Kim and Hwang (2020) applied the TPB and the norm activation model, and they found that when consumers feel a personal obligation to choose drone food delivery services, they are willing to use drone food delivery services when ordering food. On the basis of the preceding discussion, a reasonable assumption is that the more diners that feel obligated to use robotic restaurants, the more they are likely to use these restaurants.

Hypothesis 9: Personal norm will have a positive influence on the behavioral intention to use robot restaurants.

3. Methodology

3.1. Measurement

The measurement items for the four TAM constructs, which include perceived ease of use, perceived usefulness, attitude, and behavioural intentions, were borrowed from Davis (1985) and Min et al. (2018). In addition, the measurement items for the four TPB constructs, which include attitude, subjective norm, perceived behavioural control, and behavioural intentions, were cited from Ajzen (1991) and Han and Hyun (2017). Lastly, the personal norm was measured using three items employed by Han and his colleagues (2019) and Schwartz (1977). These measures were assessed using a seven-point Likert scale that ranged from 1 (strongly disagree) to 7 (strongly agree).

The following three groups thoroughly reviewed the questionnaire in order to assess the content validity that involved (1) three university professors, which included 2 food service management majors and 1 computer science major, (2) three PhD students who have worked in the restaurant industry, and (3) restaurant employees with substantial knowledge about restaurant automation systems. Consequently, the three groups confirmed that there are no problems in the content validity in the first version of the questionnaire.

3.2. Data collection

After checking the content validity, a pretest was conducted using an online questionnaire survey in order to check the reliability of the measurement items. The majority of South Korean people lack knowledge about robotic restaurants, because these restaurants are not activated in South Korea. In order to address this situation, two videos that are related to robotic restaurants were provided to 50 restaurant respondents before the survey began, which is available in the Appendix. The two videos were designed to be easy for anyone to understand the operation of robotic restaurants. For example, the first video shows the process of ordering food at a robot restaurant and the process of robots cooking for about a minute. The second video shows the process of preparing the food ingredients and delivering food to the customers at a robot restaurant, which is given in the Appendix. The results of the data analysis showed that all Cronbach's alpha values for each of the seven constructs exceeded .07, which indicated that all the constructs achieved high levels of reliability (Nunnally, 1978).

After conducting the pretest, the main data collection was performed using the same manner as the pretest. The questionnaire survey was distributed to 2794 restaurant customers using an online sampling company in South Korea. The respondents participated in the survey after watching the same two videos that were used in the pretest. A total of 465 respondents participated in this survey, but 49 of them were excluded due to the visual inspection and the Mahalanobis distance check. As a result, 416 respondents were used for the statistical analysis.

4. Data analysis

4.1. Descriptive statistics

Out of the 416 respondents, 49.3% are male ($n = 205$) and 50.7% are female ($n = 211$). The respondents in their 20s accounted for 34.9% ($n = 145$), and 30s totalled 29.3%

Table 1. Profile of the survey respondents ($n = 416$).

Variable	<i>n</i>	Percentage
<i>Gender</i>		
Male	205	49.3
Female	211	50.7
<i>Age</i>		
20s	145	34.9
30s	122	29.3
40s	84	20.2
50s	65	15.6
Mean age = 36.83 years old		
<i>Monthly house income</i>		
\$6,001 and over	26	6.3
\$5,001–\$6,000	8	1.9
\$4,001–\$5,000	37	8.9
\$3,001–\$4,000	60	14.4
\$2,001–\$3,000	98	23.6
\$1,001–\$2,000	113	27.2
Under \$1,000	74	17.8
<i>Marital status</i>		
Single	227	54.6
Married	182	43.8
Widowed/divorced	7	1.7
<i>Education level</i>		
Less than high school diploma	64	15.4
Associate's degree	79	19.0
Bachelor's degree	225	54.1
Graduate degree	48	11.5

($n = 122$). The average age of the respondents was 36.83 years old. The largest group reported (27.2% and $n = 113$) that they had an income between US\$1,001 and \$2,000 in regards to the income level. The largest category in regards to marital status was single people (54.6% and $n = 227$). Lastly, the majority of the respondents hold bachelor's degrees (54.1% and $n = 225$) (See Table 1).

4.2. Measurement model

The confirmatory factor analysis (CFA) results revealed that the model adequately fits the data ($\chi^2 = 350.368$, $df = 168$, $\chi^2/df = 2.086$, $p < .001$, $NFI = .962$, $IFI = .980$, $CFI = .980$, $TLI = .975$, and $RMSEA = .051$). The factor loading is equal to or above .826 ($p < .001$). Table 2 presents the variables and their standardised factor loadings in detail.

Table 3 shows that all reliability values for the constructs that range from .894 to .978 were above the suggested minimum standard of .60 (Bagozzi & Yi, 1988). In addition, the average variance extracted (AVE) was above the .50 cutoff for all constructs, which thereby indicates that the convergent validity of the measurement scales was strongly supported (Fornell & Larcker, 1981). Lastly, the discriminant validity was assessed by comparing the squared correlation (R^2) between a pair of constructs (Fornell & Larcker, 1981). The results showed that each squared correlation (R^2) between a pair of constructs was below the AVE for each construct, which thereby suggests that the discriminant validity was well established (See Figure 1).

Table 2. Confirmatory factor analysis: Items and loadings.

Construct and scale item	Standardised loading ^a
<i>Perceived ease of use</i>	
Learning to use a robotic restaurant seems easy to understand	.835
It seems easy to use a robotic restaurant when dining out	.907
It does not seem difficult to use a robotic restaurant	.902
<i>Perceived usefulness</i>	
A robotic restaurant would enable me to receive faster service	.836
Using a robotic restaurant could make it easier for me to receive service	.918
Using a robotic restaurant seems to be convenient when receiving service	.880
<i>Attitude</i>	
Unfavorable – Favourable	.921
Bad – Good	.933
Negative – Positive	.908
<i>Subjective norm</i>	
Most people who are important to me think I should use a robotic restaurant when dining out	.898
Most people who are important to me would want me to use a robotic restaurant when dining out	.964
People whose opinions I value would prefer that I use a robotic restaurant when dining out	.963
<i>Perceived behavioural control</i>	
Whether or not I use a robotic restaurant when dining out is completely up to me	.826
I am confident that if I want, I can use a robotic restaurant when dining out	.854
I have resources, time, and opportunities to use a robotic restaurant when dining out	.894
<i>Personal norm</i>	
I feel an obligation to choose technology-based services, such as a robotic restaurant when dining out	.889
Regardless of what other people do, because of my own values/principles I feel that I should use technology-based services, such as a robotic restaurant when dining out	.954
I feel it is important that consumers use technology-based services, such as a robotic restaurant when dining out	.914
<i>Behavioural intentions</i>	
I will use a robotic restaurant when dining out	.941
I am willing to use a robotic restaurant when dining out	.909
I am likely to use a robotic restaurant when dining out	.966

Goodness-of-fit statistics: $\chi^2 = 350.368$, $df = 168$, $\chi^2/df = 2.086$, $p < .001$, NFI = .962, IFI = .980, CFI = .980, TLI = .975, RMSEA = .051.

Notes 1: ^aAll factors loadings are significant at $p < .001$.

Notes 2: NFI: normed fit index, IFI: incremental fit index, CFI: comparative fit index, TLI: Tucker-Lewis index; RMSEA: root mean square error of approximation.

4.3. Structural model

The structural equation modeling (SEM) results revealed that the proposed model fit the data well ($\chi^2 = 552.799$, $df = 180$, $\chi^2/df = 3.071$, $p < .001$, NFI = .940, IFI = .959, CFI = .959,

Table 3. Descriptive statistics and associated measures.

	No. of items	Mean (Std dev.)	AVE	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Perceived ease of use	3	4.82 (.97)	.778	.913^a	.442 ^b	.423	.202	.472	.228	.436
(2) Perceived usefulness	3	4.47 (1.11)	.772	.195 ^c	.910	.535	.454	.284	.389	.509
(3) Attitude	3	4.45 (1.47)	.848	.179	.286	.944	.503	.256	.523	.757
(4) Subjective norm	3	3.08 (1.33)	.888	.041	.203	.253	.959	.188	.739	.602
(5) Perceived behavioural control	3	4.72 (1.10)	.737	.223	.081	.066	.035	.894	.226	.389
(6) Personal norm	3	3.20 (1.37)	.845	.052	.151	.274	.546	.051	.942	.611
(7) Behavioural intentions	3	4.05 (1.34)	.909	.190	.259	.573	.362	.151	.373	.978

Notes 1: AVE: average variance extracted.

Notes 2: ^aComposite reliabilities are along the diagonal, ^bcorrelations are above the diagonal, and ^csquared correlations are below the diagonal.

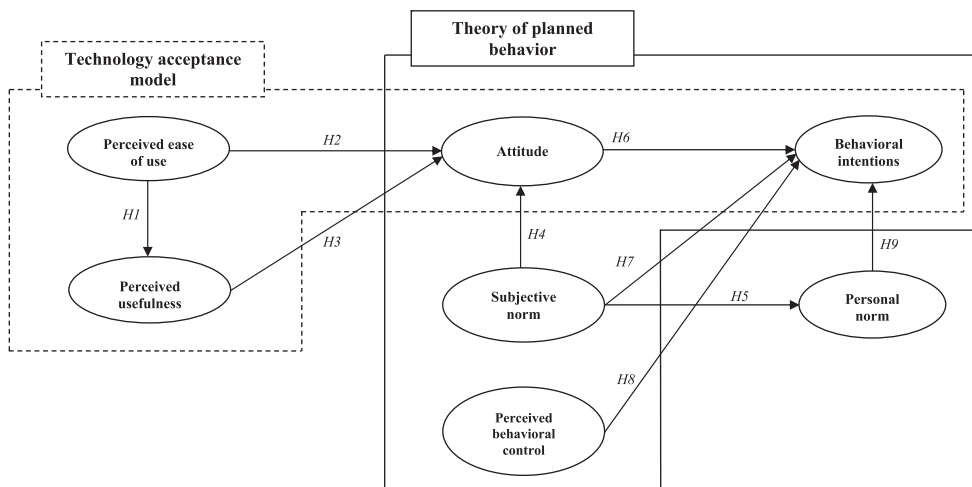
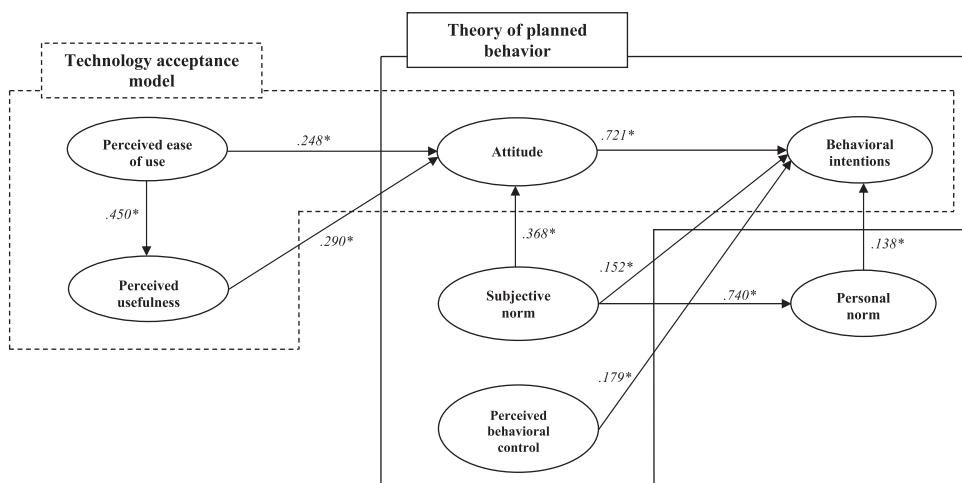


Figure 1. Proposed conceptual model.

TLI = .952, and RMSEA = .071). **Figure 2** shows the standardised and theoretical path coefficients. **Table 4** summarises the results of checking the hypotheses. The data analysis indicates that all nine hypotheses were statistically accepted. In particular H1, which proposed the relationship between perceived ease of use and perceived usefulness, is supported ($\beta = .450$ and $p < .05$). In addition, perceived ease of use ($\beta = .248$ and $p < .05$) and perceived usefulness ($\beta = .290$ and $p < .05$) positively affected attitude. Hence, H2 and H3 are supported. The data analysis results showed that subjective norm aids with enhancing attitude ($\beta = .368$ and $p < .05$) and personal norm ($\beta = .740$ and $p < .05$). Thus, H4 and H5 are supported. Attitude ($\beta = .721$ and $p < .05$), subjective norm ($\beta = .152$ and $p < .05$), and perceived behavioural control ($\beta = .179$ and $p < .05$) were



* $p < .05$

Figure 2. Standardised theoretical path coefficients. * $p < .05$.

Table 4. Moderating role of the type of employee.

				Standardised estimate	t-value	Hypothesis
H1	Perceived ease of use	→	Perceived usefulness	.450	8.959*	Supported
H2	Perceived ease of use	→	Attitude	.248	4.906*	Supported
H3	Perceived usefulness	→	Attitude	.290	5.724*	Supported
H4	Subjective norm	→	Attitude	.368	8.461*	Supported
H5	Subjective norm	→	Personal norm	.740	19.520*	Supported
H6	Attitude	→	Behavioural intentions	.721	19.038*	Supported
H7	Subjective norm	→	Behavioural intentions	.152	3.280*	Supported
H8	Perceived behavioural control	→	Behavioural intentions	.179	5.909*	Supported
H9	Personal norm	→	Behavioural intentions	.138	3.081*	Supported

Goodness-of-fit statistics: $\chi^2 = 552.799$, $df = 180$, $\chi^2/df = 3.071$, $p < .001$, NFI = .940, IFI = .959, CFI = .959, TLI = .952, RMSEA = .071.

Notes 1: * $p < .05$.

Notes 2: NFI: normed fit index; IFI: incremental fit index; CFI: comparative fit index; TLI: Tucker-Lewis index; RMSEA: root mean square error of approximation.

found to be significantly associated with behavioural intentions. Therefore, H6, H7, and H8 are supported. Lastly, a positive relationship exists between personal norm and behavioural intentions. Thus, H9 is supported.

5. Discussion and implications

5.1. Theoretical implications

First, the current research contributes to determining the formation of the consumers' behavioural intentions in tech-augmented restaurants, which is where the existing findings are limited. This means that this study was designed in order to predict the consumer behaviour in a specific service sector, which included robotic restaurants, powered by innovative technology. The extant literature on robots in the service industry is generally centred on adoptions, developments, utilities, and challenges (Eksiri & Kimura, 2015; Huang & Rust, 2018; Ivanov et al., 2017; Panwar et al., 2019). The scholars attempted to examine the consumers' responses toward robots employed in the hospitality and tourism industry (Tussyadiah & Park, 2018; Zhong & Verma, 2019), but consumer behaviour in the context of robotic restaurants has not been sufficiently explored. This means that only a handful of studies provided empirical evidence about consumer behaviour in the innovation of the restaurant industry. In particular, findings about the individuals' intention formation toward robotic restaurants are scarce. Thus, limited information is available regarding how consumers perceive robotic restaurants and how the patrons' behavioural intentions are formed toward these types of emerging restaurants in the modern world. Moreover, this research is theoretically valuable, because this is one of the few studies that articulates the formation of the consumers' behavioural intentions toward robotic restaurants.

Second, the present study is the first attempt to combine the TAM and TPB in order to explain the formation of consumer behaviour in the robotic restaurant domain. The TAM and TPB have been highly validated in order to individually predict consumer behaviour in various settings, so many attempts have also been made to improve the explaining power of the individuals' behavioural intentions based on integrative models that combine the existing theories (Kim & Hwang, 2020; Liu et al., 2017; Shin et al., 2018). Han and Hyun (2017) incorporated the TPB and the norm activation

theory in order to explain the individuals' decision-making process in the museum sector, and they demonstrated the superior prediction power of the integrated model, which is superior to prediction power of an individual theory. No attempts to date have been made to explore the consumers' behavioural intentions toward robotic restaurants based on the validated theories. The current research filled in this void and adopted the most cited theories, which include the TAM and TPB in the fields of technology adoption and consumer behaviour. The present study merged the TAM and TPB in order to understand for the first time the formation of consumer behaviour in the context of robotic restaurants. The analysis results confirmed significant associations among the study variables rooted in the combined TAM and TPB. This means that the perceived ease of use exhibited impact on perceived usefulness ($\beta = .450$ and $p < .05$), attitude ($\beta = .248$ and $p < .05$), and a strong effect of attitude on behavioural intentions ($\beta = .721$ and $p < .05$). The rationale of these results can be considered by multiple case studies that were conducted by Seyitoğlu and Ivanov (2020b). They found that the customers who have been to a robotic restaurant in the US generated a very positive attitude toward the robotic restaurants due to its fast service and convenience of ordering (Seyitoğlu & Ivanov, 2020b). On the other hand, when diners feel that the robots are *useless*, they are disappointed and negatively evaluate the robotic restaurants. For example, the robots in some robotic restaurants could only serve a limited number of items on the menu, so the human employees still had to deliver specific food items to the customers (Seyitoğlu & Ivanov, 2020b). Also, some customers found it difficult to order by using electronic screens on the robots and complained that it takes more time to order. Other deficiency problems involved with robotic restaurants included the robots' technical errors and not implementing the required task, which is not perceived as easy to use or useful to assist customers (Shead, 2019).

Moreover, the analysis results statistically supported the influences of subjective norm ($\beta = .152$ and $p < .05$) on behavioural intentions. Jang and Lee (2021) also recently found that subjective norms play a significant role in the diners' behavioural intention to visit contact-free restaurants. Humans have relationships in society and adapt themselves to the dynamics of society (Kenrick et al., 2003). Under the COVID-19 pandemic, many people agree that the robotic restaurant is a social trend, and they suggest the inevitability regarding the adoption of robotic technology in the restaurant industry (Zemke et al., 2020). Therefore, it is understandable that subjective norm plays a great role with behavioural intentions to visit a robotic restaurant.

Furthermore, the analysis results statistically supported the influences of subjective norm ($\beta = .152$ and $p < .05$) and perceived behavioural control ($\beta = .179$ and $p < .05$) on behavioural intentions. The robotic adoption rate has increased significantly since COVID-19, because the thoughts about food safety and contactless food services around the world have been reestablished (Durbin & Chea, 2020). Due to the high demand for robot adoption in restaurants, the customers may have more opportunities to visit the restaurant. As the demand increases, the price of using robotic restaurants is expected to decrease, and the customers may have more resources and control to visit robotic restaurants. As a result, this study comprehensively illustrates how the restaurant patrons' intentions are generated in robotic restaurants, which thereby enriches the current literature.

Third, personal norm was widely examined beyond the subjective norm in order to explain consumer behaviour in numerous studies, which often adopted the extension of the TPB in order to enhance its predictive power over the individuals' behavioural intentions (Han & Hyun, 2017; Huijts et al., 2012; Kim & Hwang, 2020; Liu et al., 2017; Roos & Hahn, 2019). The stream of these studies determined the strong association between subjective and personal norms and the critical role of personal norm with inducing behavioural intentions in various sectors. The results of this study uncovered the salient influence of subjective norm on personal norm ($\beta = .740$ and $p < .05$) and the significant effect of personal norm on behavioural intentions ($\beta = .138$ and $p < .05$). Therefore, our results are coherent with the existing literature (Harland et al., 1999; Jang & Lee, 2021; Klöckner, 2013; Shin et al., 2018). Furthermore, this study successfully validated the importance of personal norm in the domain of robotic restaurants. This outcome is considered to be one of the important theoretical implications, because it provides empirical evidence that a personal obligation is essential in the decision-making process that is related to the technology-driven innovation of restaurants.

5.2. Managerial implications

First, the results of the current study indicated a significant effect of perceived ease of use and perceived usefulness on the individuals' attitude, which thereby consequently influences behavioural intentions. Therefore, the professionals in robotic restaurants should endeavour to position themselves as a venue for diners to enjoy superior convenience, utmost ease, and increased efficiency. This means that the aforementioned advantages of robotic restaurants to provide operational excellence (Berezina et al., 2019; Forbes, 2020) should be innovatively advertised in order to build the image of these restaurants with high degrees of ease and usefulness. Among the various smart technologies, virtual reality (VR) was highly recognised with an immense potential to attract a great deal of customers' attention in the hospitality and tourism context (Nayyar et al., 2018; Nordbo et al., 2015). As such, innovative technologies, such as VR can be used for the consumers to visualise a dining experience at robotic restaurants with superior ease and usefulness. Streaming the journey of the restaurant patrons' dining at robotic restaurants would be an alternative means to visualise ease and usefulness. These types of promotional activities would imprint the differentiated experiences at robotic restaurants in peoples' minds, which would subsequently increase the favourable attitude toward these restaurants. Moreover, the analysis results confirmed that the close association between attitude and behavioural intentions exists in robotic restaurants. Thus, the ease of use and usefulness of robotic restaurants should be emphasised in order to enable them to continuously enhance their popularity.

Second, subjective norm was validated as an important variable that influences behavioural intentions and attitude and personal norm. Hence, a suggestion for the operators of robotic restaurants is to encourage proactive word-of-mouth in various channels and places. For example, going viral in online communities can be promoted through the postings of creative service encounters, which hosting local events could be used in order to demonstrate advanced robotic technologies and service automation. Consequently, these types of activities would lead people to spread positive word-of-mouth about robotic restaurants. Meanwhile, the COVID-19 pandemic has demanded the

need to develop new operating concepts in the restaurant industry (Ivanov et al., 2020; Moilanen et al., 2020). People are likely to be afraid of being crowded in a confined space due to the highly contagious nature of the coronavirus. Evidently, robotic restaurants operate with minimal human contact or without human encounters whatsoever, and they offer non-human contact services, which have emerged as new customer service trends since the emergence of the COVID-19 pandemic. Zeng et al. (2020) asserted that the COVID-19 pandemic drives the adoption of robotics in the hospitality and tourism industry with the transition from high-level human touch to high-level innovative technology. Accordingly, robotics can be a possible solution in a manner that will provide services with only a few employees around rather than limited customers from the operators' viewpoint as well as to build a minimally worrisome dining environment from the diners' standpoint. Thus, robotic restaurant cases, which help with the consumer dining experience during the COVID-19 pandemic, should be appropriately documented in order to induce the subjective norm toward robotic restaurants, which would thereby increase personal norm and behavioural intentions. Accordingly, the managerial implications that are associated with our findings could even be applied more to the post-COVID-19 era.

Third, perceived behavioural control was found to be an important variable that affects behavioural intention. Due to the pent-up demand under the pandemic, consumers are expected to be involved in revenge shopping (Park, 2020), which is based on the assumption that they feel safe in a consumption environment. As previously mentioned, many restaurants have to reconsider their health and safety regulations in order to reduce the risk of virus transmission and make sure that the customers feel safe while dining at their restaurant under the pandemic (Chuah et al., 2021). Therefore, it is strongly recommended for the restaurateurs to deliver an accurate message that involves robots not being biologically influenced by a virus infection, and the robotic restaurants can greatly improve sanitation. If the consumers continuously get positive stimuli about robotic restaurants from diverse channels, such as news, social media, and word of mouth, their confidence regarding using robotic restaurants can be improved. Thus, the findings of this study are expected to be helpful for the restaurateurs who have adopted robots or have plans to use robots in their restaurant under the COVID-19 pandemic and afterwards.

Lastly, the industry practitioners should recognise personal norm as a vital driving force in order to increase the popularity of robotic restaurants given that the influence of personal norm on behavioural intentions was discovered in this study. Consumers who are tech-savvy tend to possess a considerable interest and have favourable attitude toward using novel technology (Eksiri & Kimura, 2015; Ivanov et al., 2017). This situation implies to people who are particularly tech-savvy. They are more likely to have a higher level of personal norm, and the practitioners would have better chances to increase the personal norm of this type of group of people toward robotic restaurants. Therefore, considerable focus should be provided on the explorer and pioneer groups of people in the field of technology adoption. The advances in robotic restaurants are introduced in academic seminars, industrial forums, and events, which is where individuals who seek technological novelties are potentially engaged. Moreover, the benefits while dining at robotic restaurants should be emphasised. Various benefits of robotic restaurants have been addressed, including consistent quality service and substantially

customised service (Huang & Rust, 2018). These benefits should be wisely embedded into the introduction of robotic restaurants in order to enable individuals to develop personal obligations, which thereby increase behavioural intentions.

6. Limitations and future research

Despite the various implications from the course of study and the results of the empirical analyses, the current research is not free from limitations. Robotic restaurants are currently not popular in South Korea, so the participants of our survey were provided with two videos that show the operation of robotic restaurants prior to the commencement of the survey. First, the future studies are suggested to test the real cases of the diners' responses toward robotic restaurants for results that are based on actual experiences. Second, a report by Oracle (2018) indicated that half of the restaurant patrons perceived that services from robots are invasive, and 40% of the respondents showed a reluctance to visit restaurants with robotic staff. These results imply the importance of understanding the barriers in the context of robotic restaurants. Lastly, the future studies are recommended to guide the industry practitioners to mitigate the difficulties in order to stabilise robotic restaurants.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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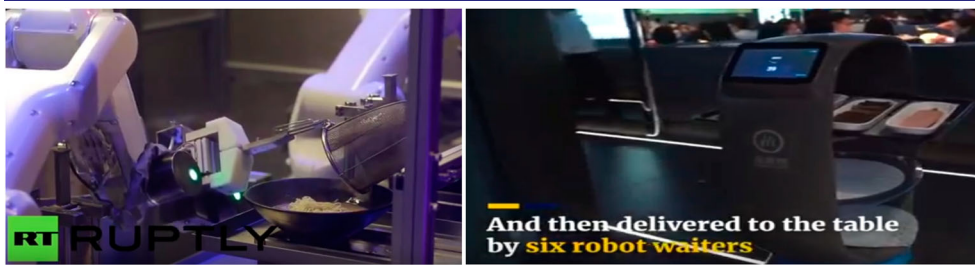
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Appendix. Screenshots from the videos.



Sources: RT UK (2016) and South China Morning Post (2018).