AI Adoption in the Chinese Food and Beverage Industry: An Exploratory Study

Yuling Wei [a]*, Attila Endre Simay [a]
[a] Institute of Marketing and Communication Sciences,
Corvinus University of Budapest
*yuling.wei@uni-corvinus.hu

Abstract - This study aims to investigate the phenomena of how artificial intelligence (AI) as one of the cutting-edge technologies benefits restaurant services and what the obstacles to implementing AI in a restaurant are. Due to the rapid pace of life, people tend to have less and less eating time, especially white-collar workers. More and more restaurants implement AI technology to improve their cooking efficiency and reduce service time, such as fast payment systems (QR and facial recognition payment), AI-enabled bots, AI-powered self-ordering kiosks, and robot chefs. Since the COVID-19 pandemic begins in early 2020, food safety and sanitation become increasingly important when people eat outside. Chef and waiter robots are good options for avoiding intimate contact. This study employed qualitative research with in-depth interviews. We interviewed three restaurant managers in China. The findings suggest that adopting AI technology in restaurant services can minimize high costs, better manage customer relationships, and provide more convenient in-store services. This study contributes to the managerial gap in AI restaurants.

Keywords: Artificial Intelligence, China, Digital Innovation, Food and Beverage Industry, Service

1. Introduction

With the increasing pressures of work and the popularity of meal delivery, an increasing number of Chinese individuals prefer order food online or eat outside. Liu and Chen (2021) found that young people aged 20 to 35 enjoy the convenience and pleasure of having food delivered to their homes. Meanwhile, Cottan et al. (2023) suggested that people tend to prefer high-quality food service when they eat outside. According to the statistical data shown, 44 percent of Chinese millennials eat at home only two days a week or less (Daxue Consulting, 2016). The phenomena was also observed by the statistical results. As Dianping (2016) shown that, Chinese millennials spent more than $23.5 million on takeout food in 2016. There are two reasons caused the phenomena: first, due to the demanding workload, there is no time and energy for them to cooking; second, the degree of convenience for food delivery (Thibaud, 2016).

According to a study by Hongdiyanto and Liemena (2021), customer loyalty towards a restaurant is positively influenced by both product quality and service quality. Product quality refers to how well a service provider, such as a restaurant or coffee shop, meets the expectations of customers (Yu & Fang, 2009). On the other hand, service quality is the difference between the actual services provided by the service provider and the customers' expectations of those services (Namin, 2017). In addition to product and service quality, Cottan et al. (2023) suggest that factors like location and atmosphere also play significant roles in enhancing customer satisfaction and loyalty. Artificial Intelligence (AI) restaurants have emerged as establishments that embrace cutting-edge technologies, such as robot chefs and waiters, to create a unique restaurant atmosphere. With the increasing popularity and acceptance of automated customer services, the demand for AI restaurants is expected to rise in the near future.

Regarding the lifestyle of Chinese millennials (i.e., rarely cooking at home), many restaurants tend to develop a new way to attract more customers dinning out. The introduction of artificial intelligence (AI) restaurants, a smart service system powered by an artificial intelligence algorithm in the food and beverage industry, is a recent development, moving away from traditional human-domain restaurants. There are few benefits for adopting AI technology in a restaurant: firstly, it can decrease human error; secondly, it can provide an automated food cooking process and table turnover; third, it can improve the speed of cooking; and lastly, it can make the whole service faster. Additionally, adopting AI technology may provide a unique customer experience (Jin, Lee, & Huffman, 2012).

The Chinese AI market is expected to grow from 1.76 billion USD in 2018 to 11.9 billion USD in 2023 (CGTN, 2019). Companies are constantly looking for new ways to reach and serve customers with their low-cost strategy (Kankam-Kwarteng, Osman, & Donkor, 2019). Food and beverage companies start to adopt cutting-edge technologies, such as AI, to improve customer service and maximize their profits. For example, Haidilao, one of Chinese most popular hotpot restaurants, has implemented an AI algorithm for its order system and robot servers in order to provide a unique customer experience and thereby attract more customers.

This qualitative study aims to answer two research questions: 1) How does AI benefit restaurants? 2) What are the obstacles to implementing AI in traditional restaurants? This study employed a qualitative research method with in-depth interviews. The author conducted in-depth interviews with two managers from traditional restaurants and one manager from AI restaurant.

The remaining of this study is structured as follows: The second section is the literature review that emphasizes what is AI, how AI affects business development, why AI is important in the food and beverage industry and AI in the Chinese market. The third section is the research methodology, and an analysis of empirical research data and information are presented. The article concludes with the implications and future directions of AI.

2. Literature review
2.1 AI introduction

As one of the most advanced technologies in industry 4.0, Artificial Intelligence (AI) has significantly improved working efficiency by replacing so many human tasks and activities in a wide range of industrial, intellectual, and social applications, including fashion, beauty, food, healthcare, retail, and supply chain (Dwivedi et al., 2021). After many years of hard work in this new field, AI has appeared in our lives as one of the newest fields in science and engineering. AI is relevant for many intellectual tasks, such as playing chess, proving mathematical theorems, writing poetry, driving a car on a crowded street, diagnosing diseases, and answering specific questions online (Russell & Norvig, 2010).

Innovation is defined as "a multifaceted phenomenon that cannot be easily squeezed into a particular branch of the social sciences or the humanities" (Fagerberg, Mowery, & Nelson, 2004, p. 3). On the other hand, innovation is not a new phenomenon; people are constantly trying to come up with new and better ways of doing things and putting them into practice (Lindfors & Hilmola, 2016). When attempting to run an effective organization, marketing strategy, method of production, and advanced technology, enterprises must keep up with innovation to survive and stand out in the market.

The definitions of AI can be summarized into four approaches: thinking humanly, thinking rationally, acting humanly, and acting rationally (Russell & Norvig, 2010). Haugeland (1985) defined AI as a mind designer in the thinking humanly approach because it is an exciting new work that could make computers think and allow machines to have minds. Bellman (1978) stated that AI is the automation of activities associated with human thinking, such as decision-making, machine learning, and problem-solving. From the perspective of rational thinking, AI

is a type of study for analyzing mental faculties using computational models (Charniak, 1985). Furthermore, Winston (1992) defined AI as the study of computations that allow rational thinking to become possible to perceive, reason, and act.

On the other hand, AI is connected with human-centered approaches that include observations and hypotheses about human behavior (Shneiderman, 2022). Kurzweil (1990) suggested that AI is a machine that performs human-like functions with intelligence. Rich and Knight (1991) defined AI as a type of study that could lead to computers or machines perfume better than human beings. To operate like humans, computers need to have four capabilities: natural language processing, knowledge representation, automated reasoning, and machine learning (Russell & Norvig, 2010). Acting rationally indicates that computational intelligence has the potential to result in the construction of intelligent agents (Poole, Goebel, & Mackworth, 1998).

AI is also referred to as intelligent behavior in artefacts (Nilsson, 1998; Langley, 2006). AI is a field of study that seeks to explain and emulate intelligent behavior in terms of computational processes (Schalkoff, 1990). AI is a branch of computer science that combines developed methods and techniques to create an intelligent computer system (Dirican, 2015; Syahrivar et al., 2021; Simay et al., 2022). AI-enabled machines can recognize human faces, languages, speech, and images, and computer models that are a precise reflection of how humans could perform such tasks (Kaplan & Haenlein, 2019). In this study, we argue that Artificial Intelligence (AI) is a type of intelligence technology that uses big data to relieve humans of work and make their lives easier.

2.2 AI in the business environment

With the growing popularity of AI, some managerial implications have received considerable attention (Sestino & De Mauro, 2022). AI can predict customer purchase behavior based on deep learning (Chaudhuri et al., 2021). Furthermore, an AI-driven matching system can help businesses identify the best internal and external capabilities, improving working efficiency and reducing operating costs (Berg et al., 2018). For instance, if logistics companies adopt AI-based matching and supply chain systems, logistic and transportation costs will be reduced, particularly in developing countries with limited access to large distribution digital networks (Ernst, Merola, & Samaan, 2019). AI algorithms have a significant impact on e-commerce platforms (Thibaud, 2016). For example, after implementing AI algorithms in Alibaba's product recommendation system and AI-powered chatbots on the customer support platform, the sales of Alibaba reached a new high of $38.4 billion on Singles' Day in 2019 (US-China Today, 2019). In 2020, the sales of Alibaba on Singles' Day set a record of up to $115 billion (Arjun, 2020).

AI is significantly important not only for e-commerce platforms but also for physical stores. Most physical stores have implemented in-store automation, back-office automation, and better supply chain management in their operations. According to Wyman (2020), in-store automation includes four components: automatic checkout, radio-frequency identification (RFID), shelf replenishment, and shelf stacking. Automatic checkout could recognize items in a basket without the need for customers or staff to intervene (Wei et al., 2020). Customers go through the process when they take products from the shelves and use the digital payment system at the same time. It is far superior to the self-service checkout. RFID also employs electromagnetic fields to identify product tags automatically (Condea, Thiesse, & Fleisch, 2012) The shelf replenishment system is primarily used to forecast product demand. According to Tang and Veelenturf (2019), AI algorithms can predict changes in demand and inventory requirements based on changes in the weather. AI algorithms can also instruct a warehouse on how to stack boxes in a truck so that they are automatically unloaded in the correct order when it comes to stacking shelves. Employees do not have to waste time looking for boxes. Back-

office automation entails using AI algorithms to read invoices and make payments without the assistance of humans. Moreover, real-time business performance can also be calculated and uploaded. Retailers have embraced digital distribution in supply chain management (Kang, Diao, & Zanini, 2021). For instance, the movement of stock from the factory to the distribution center to the retailer is fully automated. Orders are automatically placed during this process, and robots move pallets around warehouses. In terms of operation costs, automatic supply chain management can be more cost efficient and require less labor (Wyman, 2020).

2.3 AI in the catering industry

According to the Market Research Report (2022), artificial intelligence (AI) in the food and beverage industry is expected to grow at a compound annual growth rate (CAGR) of more than 45.4 percent from 2022 to 2029. A shift in consumer demands is the key driver of AI growth in the food and beverage industry. More and more consumers start to like fast, affordable, and easily accessible food options, which are driving transactions in the food and beverage industry (Ajay, 2019).

Many restaurants have implemented automation systems, AI, machine learning and chatbots to meet customer demands and aim to attract more customers. One important application of AI is automatic machine facial recognition. Robots (e.g., chefs and waiters) are an important component in AI applications. Chatbot adoption improves customer service significantly. For instance, chatbots can give guidance on food ordering without queuing (Fleming, 2019). AI in the food and beverage industry has a massive opportunity to deliver a better customer experience, such as checking food ingredients using image recognition, predicting the sales cycle using historical data, and understanding customers by monitoring consumers' emotions on social media networks.

Another important AI application in restaurants is a smart bot, which can act as waiters by making meal recommendations, taking orders, and assisting customers with payment (Sohail, Mohsin, & Khaliq, 2021). AI-enabled bots are becoming increasingly popular in restaurants. They can manage reservations, respond to customer inquiries, and assist customers with ordering. Even international chains like Starbucks and Pizza Hut use voice ordering assistants to make their service more convenient. Customers only need to say what they want to the AI-enabled bots and make payment. Facial recognition payments system is another well used AI application. For instance, KFC China has begun to use facial recognition for ordering and payment. In 2018, KFC used a "Smile to Pay" payment system in China, expanding it to 300 locations (Perala, 1998), which dramatically improved their customer experience.

2.4 Chinese market overview

Artificial Intelligence (AI) has been used in various industries, such as finance, medical, transportation, online retailing, and food and beverage (CBDIO, 2018). In China, AI applications focused on four categories in the food and beverage industry: chatbots and apps, robots, recommendation engines, and kiosks. Chatbots and apps are used to improve customer engagement by acting as virtual assistants, answering questions from customers, and processing orders. Many different types of robots are used in the food and beverage industry, including robot chefs and robot waiters. Many restaurants have decided to use AI-powered robots to increase food preparation and delivery capacity and speed. Recommendation engines are machines that assist customers in selecting meals or dishes based on their eating habits. The goal of using AI-powered Kiosks is to reduce customer waiting time while increasing customer satisfaction and order experiences (Sennaar, 2019).

In 2018, the Chinese government announced plans to open 5000 green restaurants and cut kitchen waste and energy consumption per 10,000 yuan of revenue by 20 percent by 2022. On the other hand, employing smart management systems to analyze customer preferences, and

accepting payment via QR code or facial recognition draws great attention in the food and beverage industry (Mohammed et al., 2022). Additionally, the adoption of robots is the most visible application of AI in the food and beverage industry. JD.com, a Chinese e-commerce company, announced that they intend to open 1000 smart restaurants in China by 2020, with all food prepared by robots and all customers served by robots (Daxue Consulting, 2019).

According to IiMedia (2020), the number of restaurants increased significantly between 2014 and 2019. With 7,118,058 in 2019, full-service restaurants were the most numerous in the food and beverage industry. Fast food restaurants came in second with 1,827,908, followed by food stalls with 404,284 (IiMedia, 2020). Because AI (smart) restaurants are a new type of restaurant category, there is no data for them, but an Ele.me expert predicted that they would account for only 1 percent of the total number of restaurants. The food and beverage industry has faced unprecedented occurrences because of the outbreak of the coronavirus (COVID-19) pandemic in early 2020. According to the China Hotel Association, the overall food and beverage industry's turnover decreased by more than 90 percent year on year in the first quarter of 2020, making it difficult to recoup cash flow. The merchants are under pressure from fixed costs and are suffering a significant loss during this special period. According to a recent survey, the average daily loss is up to 303,500 yuan, with restaurants accounting for 84.54 percent of the daily loss (Shen, 2020).

According to Qianxi Robot Catering Group News (2020), they opened the first Chinese fully automated restaurant Foodom in Guangdong. At the automated restaurant, 46 different types of robots are employed. In the long-term future plan, Qianxi Robotic Food and beverage Group intends to open over 1000 direct-sale stores in China within the next two years. It is currently in Changsha, Beijing, Shanghai, and other cities. For international markets, it intends to begin with the Hong Kong University of Science and Technology before expanding into the European and American markets (AGVline, 2020).

3. Methodology and data collection

This study aims to investigate Artificial Intelligence (AI) as a type of technological and digital innovation and how it can benefit restaurants and what are the obstacles to implementing AI in the restaurant. The author conducted qualitative research with in-depth interviews by following the work of (Bernard & Ryan, 2010). The validity was checked using the triangulation validity measure. The interview guide was created with four topics in mind: 1) understanding of AI technology in the food and beverage industry, 2) products and services, 3) the interaction between the customer and the restaurant and 4) the working procedure (traditional and AI restaurants). The author conducted in-depth interviews with one manager from an AI restaurant and two managers from traditional restaurants (see **Table 1**).

Table I. Respondent profile

Type of restaurants	Traditional restaurant		AI restaurant
Name	Mr. Zhang	Mr. Lin	Mr. Li
Designed abbreviation	R1	R2	AR1
Occupation	The restaurant's owner of "Gu Xiaochui"	The restaurant's owner of "Daidai Claypot Rice"	Manager at the Spacelab Weightless AI restaurant

Working experience	6 years	4 years	4 years
Nationality	Chinese	Chinese	Chinese
Region	Guangzhou, China	Guangdong, China	Beijing, China

In-depth interviews are the most common qualitative data source in restaurant service research and are frequently used in qualitative research. This method typically entails a conversation between researchers and participants that is guided by a flexible interview draft and supplemented by follow-up questions, probes, and comments (Bernard & Ryan, 2010). This method could assist the author in gathering open-ended data to investigate participants' thoughts, feelings, and beliefs about using AI in restaurants.

According to the author's situation in Hungary, who was in Hungary, and the participants were in China, every interview was conducted via online voice call. Each interview lasted between 20 and 50 minutes, and all the discussions were taped. The information was gathered between April and May of 2020. During this time, the author had no choice but to conduct online interviews due to the global coronavirus epidemic, as personal contacts were strictly prohibited. Because the interviews were conducted in Chinese, direct translations of the findings were possible.

For this qualitative study, the content analysis method was used to analyze the data. The author chose content analysis because it could handle large amounts of text and constructively summarize and categorize it, resulting in a conclusion and related evaluation. On the other hand, it performed flawlessly in both written texts and transcribed sentences from oral communication, making it appropriate for this study (Erlingsson & Briseis, 2017). However, the limitation of content analysis made it difficult to avoid human errors because there was a risk that researchers would misinterpret the data collected, resulting in false or unreliable conclusions for the study (Krippendorff & Bock, 2009).

This qualitative study seeks to answer two research questions: 1) How does AI benefit restaurants? 2) What are the obstacles to implementing AI in traditional restaurants? Whether it was based on customer needs or market demand, or if the author wanted to solve some social problems or simply make more money, qualitative research methods can assist the author in gaining a better understanding of the participants' motivations and opinions (Miles & Huberman, 1994). Ethical issues are also very important in qualitative research, they cannot be overlooked (Babbie, 2009). This study raises several ethical concerns. For instance, before the interview, the author had sent a cover letter and a consent form to each participant, requesting their permission and agreement. Furthermore, the author mentioned at the start of the interview that this interview will be voluntary and that it will be recorded for data analysis purposes later, do you agree? Each participant's response to the agreements was also recorded.

4. Findings

We presented several noteworthy codes and themes in Table 2. The themes generated in this study are: 1) high cost, 2) technological maturity, 3) hand-crafted techniques, 4) perceived ease of use, 5) cost efficiency and 6) customer relationship management.

Table 2. Themes and codes

Themes	Noteworthy codes
High Cost	Prohibitively expensive, high cost of the AI-based service system, increasingly expensive, costs more than 10 million RMB, not cost-effective….

Technological Maturity	More mature, no significant differences, AI technology is not yet mature enough, require more operating and maintenance costs…
Hand-crafted Techniques	Lacks soul, warmth, love, passion, heat control, stir-frying, velveting, and blanching are essentially important for Chinese food, overly mechanized and lacking in flexibility…
Perceived Ease of Use	AI technology's programmed and standardized production, very easy to follow, no technical thing…
Cost Efficiency	Save money on human labor, the turnover rate has increased by tenfold, up to 1,000 people, took 2–3 minutes, without any accident, make our work easier and more efficient…
Customer Relationship Management	Offering membership cards, discounts codes, and red envelopes…

High cost

The first reason participants gave for not implementing AI technology in traditional restaurants was the prohibitively high cost. According to the findings, all participants agreed that the high cost of AI was one of the main barriers to implementing AI technology in traditional restaurants. For instance, participant R1 said as follows:

"I visited Foodom Robot Restaurant one month ago, and it was great because customers were entirely served by robots as both waiters and chefs. It would be prohibitively expensive for a small restaurant due to the high cost of the AI-based service system, robot chefs, and waiters" (R1).

A previous study by Khanijahani et al. (2022). mentioned that the cost of adopting AI technology is very expensive. Moreover, the findings revealed that cost is the most important factor for entrepreneurs when deciding whether to use AI technology. New technologies are often come up with an initial setup cost that deters entrepreneurs from adopting the technology, such as AI technology (Wewege & Thomsett, 2019). Just as participant R2 mentioned as follows:

"The entire AI-based system costs more than 10 million RMB, which is a quite large amount for us. AI technology is not yet mature enough. It may require more operating and maintenance costs in the future. It is not cost-effective for me" (R2).

Another important reason why entrepreneurs do not want to use AI technology in their restaurants is a lack of knowledge about it. They may have heard about it in the market, but they are unsure how this new technology will help them save money in the long run. Knowing and studying how a new innovative technology reduces their operating costs, requires systematic training from experts (Awerbuch, 2000). The following is how the participant described his experience with AI technology:

"Yes, I am familiar with some AI technology, including QR payment, QR payment, iPad, and QR code self-ordering system. I'm also familiar with the intelligent restaurant system, which is a self-service restaurant. There are no human workers, only robots and machines. Because of the high cost, I do not think I will adopt it. I cannot afford it, too. Otherwise, there is a high risk if I do not understand how it can lower my long-term operating costs." (R2).

Technological Maturity

The technological maturity is the second barrier to implementing AI technology in traditional restaurants. Technological maturity is a theme that represents a technology's level of perfection and advancement. A previous study by Mathivathanan et al. (2021) suggested that making a new technology adoption decision in an organization or company requires a certain level of technological maturity. The participant R1 also mentioned this reason as follows:

"I think the current stage of AI technology is not mature enough. If AI technology becomes more mature in the future, I would like to adopt robots or automation intelligence machines to help me clean and cut vegetables, because I trust AI technology's programmed and standardized production." I expected it to save me some human costs and even outperform humans" (R1).

Hand-crafted Techniques

Hand-crafted Techniques is a theme that represents responses in which participants claimed that delicious food requires specific techniques such as soul, warmth, love, and passion. Especially when it comes to cooking Chinese food. Specific ingredients and techniques are essential for preparing delectable Chinese cuisine (Kwong, 2012). The following excerpt from the interview explains the importance of hand-crafted techniques for Chinese food cooking and why entrepreneurs did not use robots or machines as chefs:

"The food cooked by robot chefs lacks soul, because heat control, stir-frying, velveting, and blanching are essentially important for Chinese food. Robot chefs are still machines that cook in a preprogrammed and standardized manner. It is overly mechanized and lacking in flexibility" (R1).

The ideal situation is one in which AI technology is combined with human waiters, because AI technology can only replace a portion of human work and cannot completely replace all human work. Customers may need to communicate with human waiters at times. Just as participant Mr. Lin mentioned as follows:

"AI technology is merely a tool for us; the goal is to make our work easier and more efficient. It will never completely replace human labor" (R2).

Perceived ease of use

Perceived ease of use is the degree to which a technology or system is user friendly without additional effort or difficulty (Schnall et al., 2015). Among the main services provided by AI technology at Spacelab Weightless were food ordering, dish delivery, and payment. According to the findings, the applied AI technology is simple to use for both customers and employees. The following are the participant experiences with the service provided by AI technology in their restaurant:

"We adopted three AI track systems in each of our restaurants because it is very easy to follow for customers and there is no technical thing that is difficult for them to handle. We only need to explain a little bit to new customers about how the AI track system works in our restaurants" (AR1).

The finding indicated that employees like the applied AI technology in their restaurant. It is very easy to use the AI food delivery track system, QR payment, and iPad food ordering. Their working efficiency has increased, and they can now serve more customers per day. Just as participant AR1 mentioned as follows:

"I like and trust the applied AI technologies. There are no technical issues, in my opinion, because the AI food delivery track system, QR payment, and iPad food ordering are mature enough" (AR1).

Cost efficiency

Cost efficiency is a theme that represents responses in which participants claimed to spend the least amount of money on operating a restaurant (Mozaffari et al., 2014). According to Sopta and Komin (2017), smartly managing costs and profits is critical for any company because it determines whether the company will be successful or not. The main differences between adopted AI track systems and traditional delivery methods were that dish delivery became much faster than before, and working efficiency was greatly increased. The following response suggests how AI technology adoption was perceived by the participant:

"The AI track system only takes 17 seconds to deliver the food without any accident, whereas before it took 2–3 minutes" (AR1).

According to the findings, the speed of serving has increased by 11 times after adopting AI technology. For instance, the restaurant can serve more people during the day, the daily revenue turnover increases. Customer satisfaction is also increased by decreasing the waiting time. Participant AR1 described how many customers visited their restaurants after they implemented AI technology as follows:

"The average daily customer flow of the restaurant is up to 1,000 people, there are more customers, especially on weekends, and the turnover rate has increased by tenfold" (AR1).

Madanhire and Mbohwa (2016) argued that costs can be reduced if working efficiency is improved. The work procedures for waiters changed dramatically after Spacelab Weightless adopted AI technology, according to this study. Just as participant AR1 mentioned as follows:

"Before the adoption of AI technology, at least one waiter needed to be the cashier, and 15 more waiters needed to deliver the dishes for customers, but now we only have eight waiters in the dining room, and the main task for them is to explain to customers how our systems work and ask them if they have any special needs" (AR1).

Customer relationship management (CRM)

A previous study by Alt and Puschmann (2004) suggested that customer relationship management (CRM) has the desired benefits, such as improve customer satisfaction and retention. CRM is crucial for restaurants as well; developing a strong relationship between restaurants and customers can effectively reduce customer defection, foster long-term customer loyalty, and boost economic profits (Kebede & Tegegne, 2018). The following are statements from participant AR1, who explained how they use CRM in their restaurant:

" We are offering membership cards, discounts codes, and red envelopes for our customers. Customers can deposit money on the membership card, for example, customers can spend 225 RMB by saving 200 RMB in their card. Regarding the discount codes and red envelopes, we always send them via WeChat Official Account, but customers must first follow us on WeChat before receiving the discount codes and red envelopes from us" (AR1).

It is critical for a business to use appropriate online marketing strategies to attract customers (Teo & Swan Tan, 2002). The same is true for restaurants. For instance, sending discount codes and red envelopes via their WeChat official account is a good marketing strategy for attracting customers' attention, increasing consumption, and promoting their restaurant. The following are the experiences shared by participant AR1:

"Based on feedback from our customers, they were satisfied with our services that are

delivered by AI technology. They came here looking for a sense of modernity, fun, science, and technology. We met, if not exceeded, their expectations because the taste of our food was excellent" (AR1).

According to Hanusch and Pyka (2007), increasing a restaurant's competitiveness necessitates innovation, and adopting AI technology is one of those innovations. Being knowledgeable about the new technology, on the other hand, can help to avoid economic losses and operational risks (Malota & Mchenga, 2020). According to this study, knowing the benefits and drawbacks of implementing AI technology is critical for restaurant owners. We summarized the benefits and drawbacks of implementing AI in Chinese restaurants based on our findings (see **Table 3**).

Table 3. Advantages and disadvantages of adopting AI in Chinese restaurants

Advantages	Disadvantages
1. Reduce human errors	1. The cost of this new technology (AI) is expensive
2. Increase automation processes	2. Cooking by robot is devoid of soul
3. Increase food quality	3. The technic cost is expensive
4. Make servings more quickly	4. Need to hire technicist who is good at AI in restaurants
5. Improved security	5. The costs of background maintenance are high
6. Reduce the number of labors	
7. Reduce labor costs	6. Customers may dislike the meals cooked by robots
8. Increase the level of entertainment	7. Cultural bias
9. Increase consumers' curiously	
10. Attracted more customers	
11. Saved consumer's time	
12. Improve and transform the entire restaurant experience	
13. Increase the rate of table turnover	

5. Discussion and conclusion

"Novelty" was mentioned numerous times by interviewees when describing their experiences with AI restaurants. In fact, "novelty" is one of the most distinguishing signals of Neo-Schumpeterian economics, as the most visible form of novelty is innovation (Hanusch & Pyka, 2007). Innovation can be anything new in a market, as evidenced by well-developed technologies, new creative products, disruptive processes, and innovative organizations (Kahn, 2018). However, AI technology is an essential component of innovation, and it has a significant impact on merchant productivity, economic growth, and customer consumption (Furman & Seamans, 2019). Furthermore, AI-powered algorithms, AI-enabled bots, facial recognition payment, robots, AI-powered self-ordering kiosks, unmanned food delivery vehicles, and drones have been entering the catering industry for several years and have had a significant impact on its development. As living standards and food quality improve, a customer's greatest joys are not only to eat but also to enjoy the feeling of eating outside (Cottan et al., 2023). Therefore, adopting AI technology in restaurants is becoming more and more popular in the

food and beverage industry. In this study, we argue that AI adoption can be driven by five antecedents: 1) high cost, 2) technological maturity, 3) hand-crafted techniques, 4) perceived ease of use, 5) cost efficiency and 6) customer relationship management.

There are three barriers to implementing AI technology in traditional restaurants. First, the high cost, including both investment and operating and maintenance costs, which many merchants cannot afford. Second, the level of technological maturity, which means AI technology is still in its early stages. It could only perform simple programmed and automated tasks, whereas complex and flexible tasks still required human labor. Third, most Chinese foods still require the use of hand-crafted techniques such as soul, warmth, love, passion, heat control, stir-firing, velveting, and blanching, all of which contribute to the flavor of Chinese food. Human chefs must still play an important role in traditional restaurants to achieve high food quality.

AI technology is a great tool to improve working efficiency. In this study, we reveal several benefits of adopting AI technology. First, to begin with the adoption of any technology, perceived ease of use is always the first thing that needs to take into consideration. The finding indicates that restaurant managers are willing to adopt the one that does not require large investments and less technical skills, such as facial recognition and QR payment, an iPad or a QR code self-ordering system. Second, is the cost efficiency. Since the implementation of AI, working efficiency has significantly improved, lowering the cost of human employees. Lastly, managing customer relationships is always critical for the long-term development of a restaurant. AI-powered customer service systems can automatically analyze customer data and recommend specific dishes.

6. Limitation and future research

The main limitation of this study is that it only looked at the current state of AI technology using data that was already available. There is no other way for knowledge to be integrated, unlike in human learning. This means that if there are some inaccuracies in the data, the result, such as the AI-powered algorithms used in online platforms and dish recommendations in AI restaurants, will be inaccurate. If the data provided is incorrect, the results of the AI-powered algorithms will be affected, food delivery of riders may not arrive within 30 minutes, and customers may not like the recommended dishes.

The second limitation is the sample size of AI restaurants may be insufficient to demonstrate the results. Only one manager from an AI restaurant was interviewed due to the limited market size of AI restaurants and the difficult COVID-19 situation, which prevents many restaurants from opening. The findings may not be exhaustive enough to cover all AI restaurants. I believed that if I had the chance to interview more managers from AI restaurants, the results would be more convincing. Qualitative research, including professional interviews, cannot be conducted with a representative sample. As a result, the outcome cannot be generalized. The third limitation is society and technologies evolve over time, so findings may differ in other societies and as technological advances reshape the business and social environment.

The perceptions of participants as well as restaurant employees regarding the implementation of AI in restaurants can be used to guide future research. Future research can also look at the benefits and drawbacks of services provided by AI technology and humans to find the best solution that benefits both parties. Furthermore, future research can focus on the customers' point of view and test how human replacement by AI technology in restaurants influences customer consumption and behavior, because merchants' business decisions are always influenced by their customers' needs. All the above-mentioned future research ideas could still be implemented in the food and beverage industry's future developments. Future study may perform quantitative research to obtain empirical results.

References

AGVline, (2020). 46 台机器人的自动化餐厅，会做广式炒菜和煲仔饭，网友惊呆了 (*An automated restaurant with 46 robots can cook Cantonese-style stir-fry and clay pot rice. Netizens were shocked*). Retrieved 2 March 2020, from: https://www.agvline.com/news/show-5419.html

Ajay, M. (2019). *Artificial Intelligence (AI) in Food & Beverages Market 2019 Segmentation and Analysis by Recent Trends, Development and Growth by Regions to 2024*. Retrieved 15 March 2020, from: https://www.marketwatch.com/press-release/artificial-intelligence-ai-in-food-beverages-market-size-2020---growth-opportunities-and-trends-industry-drivers-business-plans-with-share-competitors-analysis-and-global-revenue-forecast-to-2024-2020-09-30

Alt, R., & Puschmann, T. (2004, January). Successful practices in customer relationship management. In *37th Annual Hawaii International Conference on System Sciences*, 2004. Proceedings of the (pp. 9-pp). IEEE.

Arjun, K. (2020). *Alibaba, JD set new records to rack up record $115 billion of sales on Singles Day as regulations loom*. Retrieved 9 December 2020, from: https://www.cnbc.com/2020/11/12/singles-day-2020-alibaba-and-jd-rack-up-record-115-billion-of-sales.html#close

Awerbuch, S. (2000). Investing in photovoltaics: risk, accounting and the value of new technology. *Energy Policy*, 28(14), 1023-1035. https://doi.org/10.1016/S0301-4215(00)00089-6

Babbie, E. (2009). The Basics of Social Research. Fifth edition. Belmont, CA: Wadsworth, Cengage Learning.

Bellman, R. (1978). An Introduction to Artificial Intelligence: Can Computer Think? San Francisco: Boyd & Fraser Pub. Co.

Berg, J., Furrer, M., Harmon, E., Rani, U., & Silberman, M. S. (2018). Digital labour platforms and the future of work. Towards Decent Work in the Online World. Rapport de l'OIT.

Bernard, H. R., & Ryan, G. W. (2010). Analyzing qualitative data: Systematic approaches. SAGE publications.

CBDIO, (2018). 《人工智能发展白皮书-产业应用篇（2018 年）》-《*Artificial Intelligence Development White Paper-Industrial Applications (2018)*》. Retrieved 15 April 2020, from: http://cbdio.com/BigData/2019-01/03/content_5974987.htm

CGTN, (2019). *Why can China lead in 5G and AI sectors?*. Retrieved 16 February 2020, from: https://news.cgtn.com/news/2019-09-15/Why-can-China-lead-in-5G-and-AI-sectors--K0DlmoRiAE/index.html

Charniak, E. (1985). Introduction to Artificial Intelligence. Pearson Education India.

Chaudhuri, N., Gupta, G., Vamsi, V., & Bose, I. (2021). On the platform but will they buy? Predicting customers' purchase behavior using deep learning. *Decision Support Systems*, 149, 113622. https://doi.org/10.1016/j.dss.2021.113622

Condea, C., Thiesse, F., & Fleisch, E. (2012). RFID-enabled shelf replenishment with backroom monitoring in retail stores. *Decision Support Systems*, 52(4), 839-849. https://doi.org/10.1016/j.dss.2011.11.018

Copeland, J. (1993). Artificial intelligence: A philosophical introduction. John Wiley & Sons.

Cottan, A., Purba, J., Widjaja, A., & Parani, R. (2023). Evolving Customers Expectations of Japanese Restaurants in a Post-Covid Era: Indonesia Evidence. *FIRM Journal of Management Studies*, 8(1), 73-89. https://doi.org/10.33021/firm.v8i1.4044

Daxue Consulting, (2016). *Chinese Millennials Behavior: Why are Chinese Millennials Not Cooking?*. Retrieved 22 March 2022, from: https://daxueconsulting.com/chinese-millennials-behavior/

Daxue Consulting, (2019). *AI in Food and Beverage industry in China: the future of dining starts today.* Retrieved 17 March 2020, from: https://daxueconsulting.com/ai-food-and-beverage-industry-china/

Dian Ping, (2016). 大众点评研究院：2016 中国外卖 O2O 行业洞察报告 (*Dianping Research Institute: 2016 China Food Delivery O2O Industry Insight Report*). Retrieved 5 April 2020, from: http://www.199it.com/archives/541308.html

Dirican, C. (2015). The impacts of robotics, artificial intelligence on business and economics. *Procedia-Social and Behavioral Sciences*, 195, 564-573. https://doi.org/10.1016/j.sbspro.2015.06.134

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., ... & Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, 57, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Erlingsson, C., & Brysiewicz, P. (2017). A hands-on guide to doing content analysis. African *Journal of Emergency Medicine*, 7(3), 93-99.

Ernst, E., Merola, R., & Samaan, D. (2019). Economics of artificial intelligence: Implications for the future of work. IZA *Journal of Labor Policy*, 9(1), 1-35. https://doi.org/10.2478/izajolp-2019-0004

Fagerberg, J., Mowery, D. C., & Nelson, R. R. (2004). The Oxford Handbook of Innovation. Oxford University Press. sec. 1, pp. 1-5.

Fleming, S. (2019). *The rise of the robot-restaurant: AI is ready to take your order. World Economic Forum*, Retrieved 16 March 2020, from: https://www.weforum.org/agenda/2019/09/the-rise-of-the-robo-restaurant/

Furman, J., & Seamans, R. (2019). AI and the Economy. *Innovation Policy and the Economy*, 19(1), 161-191. https://doi.org/10.1086/699936

Hanusch, H., & Pyka, A. (2007). Principles of neo-Schumpeterian economics. *Cambridge Journal of Economics*, 31(2), 275-289. https://doi.org/10.1093/cje/bel018

Haugeland, J. (1985). Artificial Intelligence: The Very Idea. MIT Press.

Hongdiyanto, C., & Liemena, K. (2021). The Mediation Effect of Customer Satisfaction in Relationship between Product Quality and Service Quality towards Customer Loyalty In Fuzee Sushi. *FIRM Journal of Management Studies*, 6(2), 172-182. https://doi.org/10.33021/firm.v6i2.1557

IiMedia, (2020). 餐饮行业数据分析：2019 年中国服务齐全的餐厅门店数量为 7118058 家 (*Catering industry data analysis: the number of restaurants with complete services in China in 2019 is 7,118,058*). Retrieved 5 May 2020, from: https://www.iimedia.cn/c1061/68473.html

Jin, N., Lee, S., & Huffman, L. (2012). Impact of restaurant experience on brand image and customer loyalty: Moderating role of dining motivation. *Journal of Travel & Tourism Marketing*, 29(6), 532-551. https://doi.org/10.1080/10548408.2012.701552

Kahn, K. B. (2018). Understanding innovation. *Business Horizons*, 61(3), 453-460. https://doi.org/10.1016/j.bushor.2018.01.011

Kang, J., Diao, Z., & Zanini, M. T. (2021). Business-to-business marketing responses to COVID-19 crisis: a business process perspective. *Marketing Intelligence & Planning*,

39(3), 454-468. https://doi.org/10.1108/MIP-05-2020-0217

Kankam-Kwarteng, C., Osman, B., & Donkor, J. (2019). Innovative low-cost strategy and firm performance of restaurants: The moderation of competitive intensity. *Asia Pacific Journal of Innovation and Entrepreneurship*, 13(3), 266-281. https://doi.org/10.1108/APJIE-05-2018-0034

Kaplan, A., & Haenlein, M. (2019). Siri, Siri, in my hand: Who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. *Business Horizons*, 62(1), 15-25. https://doi.org/10.1016/j.bushor.2018.08.004

Kebede, A. M., & Tegegne, Z. L. (2018). The effect of customer relationship management on bank performance: In context of commercial banks in Amhara Region, Ethiopia. *Cogent Business & Management*, 5(1), 1499183. https://doi.org/10.1080/23311975.2018.1499183

Khanijahani, A., Iezadi, S., Dudley, S., Goettler, M., Kroetsch, P., & Wise, J. (2022). Organizational, professional, and patient characteristics associated with artificial intelligence adoption in healthcare: A systematic review. *Health Policy and Technology*, 11(1), 100602. https://doi.org/10.1016/j.bushor.2018.08.004

Krippendorff, K., & Bock. M. A. (2009). The Content Analysis Reader. Thousand Oaks, CA: Sage.

Kurzweil, R. (1990). The Age of Intelligent Machines. MIT Press.

Kwong, K. (2012). Kylie Kwong's Simple Chinese Cooking Class. Australia: Lantern.

Langley, P. (2006). Intelligent behavior in humans and machines. In American Association for Artificial Intelligence.

Lindfors, E., & Hilmola, A. (2016). Innovation learning in comprehensive education?. *International Journal of Technology and Design Education*, 26(3), 373-389. https://doi.org/10.1007/s10798-015-9311-6

Liu, C., & Chen, J. (2021). Consuming takeaway food: Convenience, waste and Chinese young people's urban lifestyle. *Journal of Consumer Culture*, 21(4), 848-866. https://doi.org/10.1177/1469540519882487

Madanhire, I., & Mbohwa, C. (2016). Application of statistical process control (SPC) in manufacturing industry in a developing country. *Procedia Cirp*, 40, 580-583. https://doi.org/10.1016/j.procir.2016.01.137

Malota, M., & Mchenga, J. (2020). Revisiting dominant practices in floodwater harvesting systems: making flood events worth their occurrence in flood-prone areas. *Applied Water Science*, 10(1), 6. https://doi.org/10.1007/s13201-019-1096-4

Market Research Report, (2022). *Artificial Intelligence Ai In Food and Beverages Market*. Retrieved 22 March 2022, from: https://www.polarismarketresearch.com/industry-analysis/artificial-intelligence-ai-in-food-and-beverages-market#:~:text=The%20global%20artificial%20intelligence%20in,45.4%25%20during%20the%20forecast%20period

Mathivathanan, D., Mathiyazhagan, K., Rana, N. P., Khorana, S., & Dwivedi, Y. K. (2021). Barriers to the adoption of blockchain technology in business supply chains: a total interpretive structural modelling (TISM) approach. *International Journal of Production Research*, 59(11), 3338-3359. https://doi.org/10.1080/00207543.2020.1868597

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook. Thousand Oaks, CA: Sage Publications.

Mohammed, U. S., Shukla, V. K., Sharma, R., & Verma, A. (2022). Next Step to the Future of Restaurants Through Artificial Intelligence and Facial Recognition. In *Cyber Intelligence and Information Retrieval: Proceedings of CIIR 2021* (pp. 89-101). Springer Singapore.

Mozaffari, M. R., Kamyab, P., Jablonsky, J., & Gerami, J. (2014). Cost and revenue efficiency in DEA-R models. *Computers & Industrial Engineering*, 78, 188-194. https://doi.org/10.1016/j.cie.2014.10.001

Namin, A. (2017). Revisiting customers' perception of service quality in fast food restaurants. *Journal of Retailing and Consumer Services*, 34, 70-81. https://doi.org/10.1016/j.jretconser.2016.09.008

Nilsson, N. J. (1998). Artificial intelligence: A New Synthesis. Morgan Kaufmann.

Poole, D. I., Goebel, R. G., & Mackworth, A. K. (1998). Computational intelligence: A logical approach. New York: Oxford University Press.

Qianxi Robot Catering Group News, (2020). *Intelligent Restaurant, Ai Taste of the World | Qianxi Strategy Launch and Opening of the World's First Robot Restaurant Complex.* Retrieved 22 March 2022, from: https://en.qxfoodom.com/show-31-199.html

Rich, E. & Knight, K. (1991). Artificial Intelligence. McGraw-Hill, New York.

Russell, S. J. & Norvig, P. (2010). Artificial Intelligence: A Modern Approach. Pearson, Essex.

Schalkoff, R. J. (1990). Artificial intelligence engine: An Engineering Approach. McGraw-Hill, New York.

Schnall, R., Higgins, T., Brown, W., Carballo-Dieguez, A., & Bakken, S. (2015). Trust, perceived risk, perceived ease of use and perceived usefulness as factors related to mHealth technology use. *Studies in Health Technology and Informatics*, 216, 467.

Sennaar, K. (2019). *Examples of AI in Restaurants and Food Services*. Retrieved 12 April 2020, from: https://emerj.com/ai-sector-overviews/ai-in-restaurants-food-services/

Sestino, A., & De Mauro, A. (2022). Leveraging artificial intelligence in business: Implications, applications and methods. *Technology Analysis & Strategic Management*, 34(1), 16-29. https://doi.org/10.1080/09537325.2021.1883583

Shen, Y. (2020). 特写：疫情寒冬中国餐饮娱乐企业苦苦支撑 有多少能熬到春暖花开？ (*Feature: How many Chinese catering and entertainment companies are struggling to survive the cold winter of the epidemic?*). Retrieved 5 May 2020, from: http://news.stcn.com/2020/0413/15833078.shtml

Shneiderman, B. (2022). Human-centered AI. Oxford University Press.

Simay, A. E., Wei, Y., Gyulavári, T., Syahrivar, J., Gaczek, P. and Hofmeister-Tóth, Á. (2022), The e-WOM intention of artificial intelligence (AI) color cosmetics among Chinese social media influencers. *Asia Pacific Journal of Marketing and Logistics*, In press. https://doi.org/10.1108/APJML-04-2022-0352

Sohail, M., Mohsin, Z., & Khaliq, S. (2021, November). User Satisfaction with an AI-Enabled Customer Relationship Management Chatbot. In *International Conference on Human-Computer Interaction*, HCII 2021, 279-287. Springer, Cham.

Sopta, M., & Komin, A. (2017). Operational analysis of company costs. Economic and Social Development: Book of Proceedings, 74.

Syahrivar, J., Gyulavári, T., Jászberényi, M., Ásványi, K., Kökény, L., & Chairy, C. (2021). Surrendering personal control to automation: Appalling or appealing?. *Transportation Research Part F: Traffic Psychology and Behaviour*, 80, 90-103. https://doi.org/10.1016/j.trf.2021.03.018

Tang, C. S., & Veelenturf, L. P. (2019). The strategic role of logistics in the industry 4.0 era. *Transportation Research Part E: Logistics and Transportation Review*, 129, 1-11. https://doi.org/10.1016/j.tre.2019.06.004

Teo, T. S., & Swan Tan, J. (2002). Senior executives' perceptions of business-to-consumer (B2C)

online marketing strategies: the case of Singapore. *Internet Research*, 12(3), 258-275. https://doi.org/10.1108/10662240210430937

Thibaud, (2016). *Chinese Millennials Behavior: Why are Chinese Millennials Not Cooking?* Retrieved 7 December 2020, from: https://daxueconsulting.com/chinese-millennials-behavior/

US-China Today, (2019). *Big Bucks on China's Singles Day: Q&A with Steven Lu*. Retrieved 22 March 2022, from: https://uschinatoday.org/qa/2019/12/30/big-bucks-on-chinas-singles-day-qa-with-steven-lu/

Wei, Y., Simay, A.E., Agárdi, I., Syahrivar, J., and Hofmeister-Tóth, Á. (2022), Using Artificial Intelligence to Promote Branded Color Cosmetics: Evidence from Indonesia. *Journal of Promotion Management*, In press, https://doi.org/10.1080/10496491.2022.2163036

Wei, Y., Tran, S., Xu, S., Kang, B., & Springer, M. (2020). Deep learning for retail product recognition: Challenges and techniques. *Computational Intelligence and Neuroscience*, 2020. https://doi.org/10.1155/2020/8875910

Wewege, L., & Thomsett, M. C. (2019). The Digital Banking Revolution: How Fintech Companies are Transforming the Retail Banking Industry through Disruptive Financial Innovation. Walter de Gruyter GmbH & Co KG.

Winston, P. H. (1992). Artificial Intelligence (Third edition). Pearson.

Wyman, O. (2020). *AI: not just for online stores.* Retrieved 8 March 2020, from: https://www.oliverwyman.com/our-expertise/insights/2019/dec/retail-consumer-journal-vol-7/ai-not-just-for-online-stores.html

Yu, H., & Fang, W. (2009). Relative impacts from product quality, service quality, and experience quality on customer perceived value and intention to shop for the coffee shop market. *Total Quality Management*, 20(11), 1273-1285. https://doi.org/10.1080/14783360802351587