

Article

The Sustainable Innovation Design in Catering Service

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Abstract: COVID-19 has impacted the whole world since 2019, especially the dietary patterns of customers. Before the pandemic, some companies had been monitoring the operation data for health and food safety situations. It has become a vital mission to improve the food production and service process if the companies wish to pursue the sustainability of their businesses due to the general environment being changed by the epidemic. The sustainability of food systems inherently implies not only customer satisfaction but also the saving of costs. The catering service must find new ways to increase customer loyalty and satisfaction while implementing improved practices for building their brand image and modern decoration. The objective of this article is to discuss the service innovation process in order to investigate the interrelationships of catering environmental policy and psychological effects in the service function. The data were collected from a DINESERV questionnaire, comprised service quality standards, to increase the customer satisfaction for a mobile dining car. Finally, the TRIZ or Kano is a standardized measure designed to improve the idealization of strategy for selecting the most appropriate service quality model. This study presents the results from the survey and discusses future perspectives of increasing the sustainability of service within a catering information system.

Keywords: sustainable business; service innovation; TRIZ; mobile catering; COVID-19



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1. Introduction

In 2016, the sustainable development goals (SDGs) replaced the Millennium Development Goals to become the future achievement blueprint of the United Nations by 2030. There is also a similar concept called Service 4.0, which has been developed recently. The Singapore government has proposed the Service 4.0 strategy for the next generation. The strategy intends to combine value-added and productive service processes with technology for meeting the changing needs of customers [1]. With the development of catering businesses and the growth of business chains, companies will develop a competitive advantage through a business model in differentiated catering product markets. Mobile catering is a great way to expand existing restaurant sales or break into the catering industry. Mobile technology plays a major role in the innovation of the service industry [2]. Moreover, an integrated system to assist transparent and responsive decision-making for management can support organizations with innovation and sustainability in order to consolidate the competitive advantage [3]. Kumar et al. [4] developed a food delivery app (FDA) for evoking emotions that predicts the continued usage intentions for FDAs, especially during the mobility limitations of the COVID-19 pandemic. Wang et al. [5] developed and validated a mobile catering app success model based on the e-commerce system success model.

The main purpose of this article is to design an integrated system that optimizes the operation process, satisfies customer needs, and improves the service quality for the mobile catering industry. What customers want and need is not just a specific commodity but also an intangible service, which is also a product. Hence, physical goods, service, experiences,

people, places, rights, concepts, and creative ideas are all part of a product. The practicality of the proposed methodology is demonstrated through the Kano model with TRIZ. A review of the literature indicates that it is critical to obtain the priority of important service quality attributes by using the TOPSIS and TRIZ methods. Therefore, the main purpose of this article is to integrate the service quality of mobile catering with TRIZ through the Kano model. For these objectives to be achieved, this article is structured as follows. Section 2.1 provides a brief review of the catering service. Section 2.2 provides the service quality and catering application characteristics [6]. Section 2.3 presents the research methodology of the Kano model. In Section 2.4, the problems are transformed and solved based on the sub-field model in TRIZ after the service quality is used to analyze the complexity of promoting the development and research of sustainability innovation.

2. Theoretical Foundation

2.1. Catering Service

Catering is the business of providing food services at remote sites such as hotels, hospitals, pubs, airports, cruise ships, parks or event venues. The catering service industry is a special category of the service industry, which emphasizes the provision of food, beverages, and related services. In Taiwan, restaurants and food shops sometimes provide catering services for the diverse demands of customers. Since 2012, when the online food ordering and delivery services such as Foodpanda and Uber Eats were introduced into Taiwan, the catering service has been affiliated with the ordinary restaurants and beverage shops to some extent. According to the Ministry of Economic Affairs (MOEA) [7], the total turnover of Taiwan's food service sector was more than 811 NTD in 2019. Table 1 presents that the food service industry has had a stable growth over the past decade but experienced a significant decline in 2020 due to COVID-19. As a result, the food service industry in Taiwan is compelled to consider innovation to survive the severe changes in the food service environment.

Table 1. Turnover in food services, 2011–2020.

The Turnover of the Food Service Industry in Taiwan (2011–2020)										
Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Amount	483.9	525.8	561.0	606.6	653.8	710.9	737.4	777.5	811.6	777.6

Recently, European Union (EU) policy [8] has been primarily concerned with food autonomy and local agriculture and counteracting the negative externalities of globalization, and has set up goals to promote the re-organization of the catering system through innovative models to improve local economic sustainability. In other words, the development of an innovative and sustainable business model is the essential and immediate task for the catering service industry in Europe and, later, worldwide. According to a report published by the catering services and food contractors' global market [9] in 2021, the global catering services market is expected to grow from USD 234.56 billion in 2020 to USD 251.82 billion at a compound annual growth rate (CAGR) of 7.4%. This growth is mainly due to companies rearranging their operations and recovering from the impact of COVID-19, which had previously led to restrictive containment measures involving social distancing, remote working, and the closure of commercial activities that resulted in operational challenges.

2.2. Catering Application Characteristics

Catering applications are designed to run on a mobile device, which could be a smart-phone or a tablet computer. [10] observed that the mode transformed from traditional enterprise to e-commerce, and puts forward some suggestions for business models from the perspective of managers. [11] noted that mobile users consider the link between human interaction and social communication to be more crucial than entertainment for mobility markets and personalized meal recommendations. The study in [12] developed an intellec-

tual tracking app system that improved work efficiency and profitability for the logistics company, based on an IoT (Internet of Things) and RTLS (Real-Time Location System). Study [13] offered an “urban food procurement model (URP-model)” based on public mass catering, fed by local and short supply chains, and considered the Milan metropolitan region as a case study. [14] assessed the performance of innovative U-commerce food app platforms in the restaurant service. In [15], consumer preferences for the application of an E-menu solution in public catering services in the UK, Greece, France, and Denmark were investigated. [5] developed a catering app success model based on the e-commerce system success model and marketing literature. The study in [16] provided extensive discussions of the crucial factors for the use of food delivery apps before and during the COVID-19 pandemic. To reduce the risk of spreading COVID-19 and to protect the health of customers and visitors in restaurants, pubs, bars, nightclubs, and takeaway venues, catering services encouraged using contactless payments where possible and making orders for takeaway or delivery online, on apps or over the telephone. Caterers have specific needs for managing food processing and distribution, which are addressed by catering apps. Catering apps represent a major proportion of a wide variety of applications, including apps for grocery delivery, food delivery, food coupons, recipes, food and nutrition information for gym enthusiasts, restaurant table reservations, food waste reduction, calorie trackers, reviews and rating, and AR-based apps for exploring restaurants. The research is still at an early stage in evaluating the service quality of mobile catering, not to mention a paucity of literature on this subject. For convenience, Table 2 indicates a brief comparison of the results of these studies.

Table 2. A complete comparison of studies on catering apps.

References	Applications	Main Characteristics
[17,18]	Grocery delivery	Data mining; Supplemental Nutrition Assistance Program (SNAP)
[19,20]	Food delivery	Smart Partial Least Squares (PLS); Expectancy Confirmation Model (ECM); Unified Theory of Use and Acceptance of Technology model (UTAUT); Pleasure Arousal Dominance (PAD)
[21,22]	Food coupons	RFID; price discrimination
[23–25]	Recipes	COOKIT; Android smartphone; robustly processes speech I/O
[26–28]	Food and nutrition for gym enthusiasts	AHP; self-tracking
[29,30];	Restaurant table reservations	eCRM; RevPASH (Revenue Per Available Seat Hour)
[31]	Food waste reduction	Internet of Things
[32–34];	Calorie trackers	Eating disorder pathology; iOS, RFID
[35,36];	Reviews and rating	Coding scheme (TBP and ACO); iOS; Android
[37,38];	AR-based apps for exploring restaurants	Immersive technology; (A)Symmetric Approach; AppSheet; Google Apps Script

2.3. Kano and TRIZ Models

The authors of [39] observed and interpreted the evolution of restaurant customers’ dining patterns and satisfaction during the COVID-19 pandemic. The research contributed critically important insights into the development of sustainable businesses. The Kano model of customer satisfaction classifies product attributes based on how they are perceived by customers and their effect on customer satisfaction. The authors of [40] noted the importance of customer satisfaction using Kano’s model with a quality function. Study [41] proposed a discussion on customer satisfaction based on Kano’s model, with a case study

from the ski industry. Based on the responses to the questions in Table 3, the customer requirement (how good gas mileage is, in the example) can be classified into one of six categories: A = Attractive; M = Must-be; O = One-dimensional; I = Indifferent; R = Reversal; and Q = Questionable. Djekic et al. [42] determined oral processing parameters with the mechanical properties of selected confectionery products and categorized oral processing based on a Kano model. Five types of product requirement that influenced customer satisfaction in this article can be further categorized as Must-be quality, One-Dimensional quality, Attractive quality, Indifferent quality, and Reverse quality. Further, TRIZ approaches are widely used in service design tools and idea generation practices, which offer a systematic problem-solving methodology. TRIZ approaches can be traced back to [43]. TRIZ consists of 39 parameters, identified through patent analysis, in a matrix in which technical contradictions can be detected. It also outlines 40 principles of creative invention to resolve the contradictions, and solutions are achieved by matching the contradiction with the relevant principle. In a recent article on TRIZ evolution trends (TETs), [44] proposed an innovation process via TRIZ evolution trends and the push and pull of technology and market. To classify the product features, the participants provided the five answers in the evaluation in Table 3. The configuration index indicates a decision factor for selecting the functional requirement (FRs) of the product configurations. On the other hand, the Kano evaluator is useful in gaining a thorough understanding of a customer's satisfaction and the producer's capacity. A comprehensive process model is proposed to integrate these techniques for customer need analysis.

Table 3. Kano evaluation table.

Customer Requirements		Dysfunctional Form of the Question				
		I. Like	II. Must-Be	III. Neutral	IV. Live with	V. Dislike
Functional form of the question	Like	Q	A	A	A	O
	II. Must-be	R	I	I	I	M
	III. Neutral	R	I	I	I	M
	IV. Live with	R	I	I	I	M
	V. Dislike	R	R	R	R	Q

A: Attractive; O: One-dimensional; M: Must-be; Q: Questionable result; R: Reverse; I: Indifferent.

2.4. The TOPSIS Method

The TOPSIS method is the Technique for Order Preference by Similarity to Ideal Solution. The ideal solution (also called the positive ideal solution) is a solution that maximizes the benefit criteria/attributes and minimizes the cost criteria/attributes, whereas the negative ideal solution (also called the anti-ideal solution) maximizes the cost criteria/attributes and minimizes the benefit criteria/attributes. The so-called benefit criteria/attributes are those for maximization, while the cost criteria/attributes are those for minimization. Study [45] attempts to formulate a sustainable manufacturing strategy for food manufacturing firms by applying the fuzzy AHP–TOPSIS method. Study [46] proposed a hybrid method integrating the AHP–DEMATEL method and the ideal solution (TOPSIS) to evaluate the performance of a pork supplier. The authors of [47] developed a framework that evaluated supermarket food safety and revealed its strengths and weaknesses by applying the AHP and TOPSIS methods. Study [48] proposed an AHP–TOPSIS approach for improving quality assurance in the perishable food supply chain. The authors of [49] point out the quality of the financial performance and efficiency of food retailers in Serbia, based on the AHP–TOPSIS method. Although much work has been carried out to date, more studies need to be conducted in order to ascertain the effects of the Kano and TRIZ models on creative performance in a variety of industries. Previous studies have shown that TRIZ provides significant advantages for technical problem solving, innovation, technology forecasting and planning, business management, etc. However, there is a particular

lack of systematic research into the utilization of TRIZ for caterers, which requires further attention.

2.5. Creative Performance

Creativity is the ability to make new and innovative products. Creative performance can be analyzed and accessed by processes and outcomes [50]. Creative problem solving (CPS) is a way of solving problems or identifying opportunities when conventional thinking has failed. The creative outcome is to do with the innovativeness of the created products.

2.6. Creative Products

The creative product analysis matrix (CPAM) is a common tool for assessing creative products based on three factors: novelty (e.g., originality, being the first); resolution (logic, usefulness, appropriateness, ability to solve problems); and elaboration and synthesis (aesthetic considerations, beauty). In the area of engineering design, however, creative products must be novel, inventive, and valuable. This article may be critically important in laying the groundwork for understanding how TRIZ is the most structured method for the creativity enhancement used in the catering industry. Many others, including [51–54], have indicated a TRIZ-based approach for developing innovative products.

2.7. Application of Contradiction Matrix in Catering Industries

There were several attempts to apply TRIZ in catering industries. The application of TRIZ in catering industry technology was suggested by [55,56]. Forty inventive principles for use in a kitchen system were proposed by [57]. To date, however, few studies have been conducted on the application of TRIZ on service innovations in the catering industry. A TRIZ evolution trend (TET) was developed for predicting the future development of technological systems and anticipating market demands in the catering industry [58].

This article adopts the Kano and TRIZ methods in the context of mobile catering for two prime reasons. First, previous studies have confirmed that operation management in the physical environment, such as websites or apps, can be effectively developed by user interface (UI) design. Second, the crisis of the COVID-19 pandemic generated emotions among people which can be assessed by catering apps as they provide a visualized overarching framework to research the impact of environmental stimuli, which in turn, evoke emotions among the consumers. Caterers are turning their sight to contactless payment and delivery and takeaway services to sustain their businesses. Clients also need new technology to help them to enjoy meals while maintaining social distancing, including mobile catering solutions. At present, research focusing on the use of catering apps would improve service processes during the COVID-19 pandemic.

3. Research Methods

3.1. Data Collection and Information

The primary criterion for selecting subjects was customers who use catering apps. Offline data collection was not possible during the pandemic, so we reached out to participants through online channels. The participants in the study, chosen from a multi-prong approach, were recruited and followed recommendations for data collection on catering apps. Data were collected from primarily young people in Taichung city, as they are adept at using smartphones. Data were collected over a period of 6 weeks during the pandemic. We reached out to 500 consumers and, after factoring in for outliers and missing responses, we received 458 valid responses indicating a 91.6% response rate (Table 4).

Table 4. Sample profile.

Variable		Frequency	Percent %
Gender	Male	159	34.7%
	Female	299	65.3%
Age	20 and under	77	16.8%
	21–30	290	63.3%
	31–40	59	12.9%
	above 41	0	7%
Education	Below high school	5	1.1%
	High school/vocational	23	5.0%
	Undergraduate	359	78.4%
	Graduate and above	71	15.5%
Monthly Income	Less or equal to 18,780 NTD	214	46.7%
	18,781–22,800 NTD	30	6.6%
	22,801–28,800 NTD	86	18.8%
	28,801–36,300 NTD	56	12.2%
	36,301–45,800 NTD	29	6.3%
	45,801–54,800 NTD	3	0.7%
	54,801–57,800 NTD	16	3.5%
	More than 57,801 NTD	24	5%
Consumption Location	Park	180	15.9%
	Shopping district	227	20.1%
	Traditional markets	165	14.6%
	Night market	277	24.5%
	Sightseeing spot	283	25%
Single consumer expenditure	Less or equal to 50 NTD	125	27.3%
	51–100 NTD	259	56.6%
	101–150 NTD	34	7.4%
	More than 151 NTD	40	8.7%

Note: Sample size is 458.

3.2. Participants

This article used a questionnaire to sample the views of 458 end-user customers. Individuals with experience in using catering apps to order meals were recruited to participate in the survey. As shown in Table 4, participants were 34.7% male and 65.3% female. They came from various regions of Taichung. The subjects were asked to fill out a questionnaire which elicited information concerning his or her attitude and motivation. In total, 46.7% of participants had an income of less than NTD 18,780, 6.6% of participants had an income of NTD 18,781–22,800, 18.8% of participants had an income of NTD 22,801–28,800, and 12.2% of participants had an income of NTD 28,801–36,300. Further, 15.9% of participants were in the park location group, 20.1% of participants were in the shopping district location group, 14.6% of participants were in the traditional market location group, 24.5% of participants were in the night market location group, and 25% of participants were in the sightseeing spots location group.

3.3. Frequency Analysis of Takeaway Orders

Online ordering has steadily increased over recent years and the COVID-19 pandemic has accelerated the adoption of digital tools and online ordering. Eating behaviors were significantly changed during the COVID-19 pandemic. Eating meals from restaurants and consuming pre-prepared food declined from 1.98 times per week to 1.08 times per week, while cooking meals at home increased from 4.49 to 5.18 days per week, according to [59]. In 2021, restaurants expect 62% of their revenue to come from takeaways and deliveries. The on-demand food delivery/collection platform Foodpanda surveyed nearly 1000 of its customers regarding their motivations for choosing takeaway orders. Approximately 44% of the participants agreed with the statement that ordering takeaway was a way

to save both time and money (i.e., avoiding delivery fees with order collection). The participants predominantly collected their food orders and ordered takeaways multiple times a week during both March and April. Their ages ranged from 35–54. More than 82% of the respondents took their food home to eat after picking their order up from the restaurant. Mobile technology has been leveraged in a number of ways to control the spread of COVID-19. Mobile apps are accessible, acceptable, and easily adopted, and they have the ability to support social distancing efforts.

3.4. Questionnaire

Over the past few months, online orders and takeaways have become a lifeline for restaurants across the globe. While the COVID-19 pandemic is the toughest challenge the industry may have ever had to face, it does illustrate the remarkable resilience of restaurants, who shifted their entire business models overnight. In 2021, restaurants expect 62% of their revenue to come from takeaways and deliveries. The on-demand delivery/collection platform Foodpanda surveyed nearly 1000 of its customers regarding their motivations for choosing takeaway orders. According to the report published by [60], approximately 41% of the participants agreed with the statement that they ordered takeaway as a way to save both time and money (i.e., avoiding delivery fees by collecting the order). The participants predominantly collected their food orders and ordered takeaways multiple times a week during both March and April, and there was an order growth in the UK of +33%, +38% in the Netherlands, +48% in Germany, and +97% in Canada. Almost all markets most significantly affected by the COVID-19 crisis have now recovered to above pre-crisis order levels.

Further evaluations of the index-quality method described by [41] are in this article. The result of the customer satisfaction (CS) coefficient of order items for the study was developed based on published studies in the catering industry. We identified the global rank of ES and ED and they are shown below.

Extent of satisfaction (ES)

$$\frac{A + O}{A + O + M + I} \quad (1)$$

Extent of dissatisfaction (ED)

$$\frac{O + M}{(A + O + M + I) \times (-1)} \quad (2)$$

The relative CS of all behavioral indicators is shown in Tables 5 and 6, which show that the CS analysis between ES and ED is comparative. An examination of the content of the final items making up each of SERVQUAL's five dimensions summarizes the scores for the ES and ED in mobile catering. Through Table 6, we are able to obtain an insight into what caterers perceive to be important in relation to the good service quality of apps. The 29 behavioral indicators included: TA dimensions, ES "TA2 = The caterer provides you with an attractive physical environment for dining (the scores = 0.726; the rank = 3)" and ED "TA9 = The app is easy to use (the scores = −0.6150; the rank = 10)"; RE dimensions, ES "RE13 = The caterer provides a menu that meets customer requirements (the scores = 0.6024; the rank = 19)" and ED "RE13 = The caterer provides a menu that meets customer requirements (the scores = −0.7882; the rank = 1)"; RES dimensions, ES "RES18 = The caterer provides a good service to customers with special needs (the scores = 0.700; the rank = 7)" and ED "RES19 = When you have a problem, the app service shows a sincere interest in solving it (the scores = −0.6380; the rank = 7)"; AS dimensions, ES "AS25 = The app frequently offers new catering products (the scores = 0.682; the rank = 9)" and ED "AS22 = The staff provide you with a great deal of free catering information and assistance (context menu, cooking) (the scores = −0.6660; the rank = 4)"; EM dimensions, ES "EM28 = The caterer improves customer services by maximizing profits (the scores = 0.747; the rank = 1)" and ED "EM27 = The staff show empathy to strong customer satisfaction and loyalty (the scores = −0.6456; the rank = 5)".

Table 5. Indicators of each dimension.

Dimension	Indicator
Tangibles (TA)	TA1. The caterer provides you with a clean parking lot.
	TA2. The caterer provides you with an attractive physical environment.
	TA3. The caterer provides their employees with a generic uniform.
	TA4. The caterer incorporates great design elements into brand identity.
	TA5. The caterer offers more clarity on menu labeling.
	TA6. The caterer creates an attractive menu card that helps the audience browse through the available options.
	TA7. The caterer provides you with a comfortable physical environment.
	TA8. The app provides you with sufficient information.
	TA9. The app is easy to use.
	TA10. The app frequently offers mobile coupons.
Reliability (RE)	RE11. The caterer makes sure that all food comes at the right time to prevent customers from waiting any longer.
	RE12. The caterer is quick thinking and has problem-solving skills.
	RE13. The caterer provides a menu that meets customer requirements.
	RE14. The app provides the precise information needed
	RE15. The app has met your expectations
Responsiveness (RES)	RES16. The caterer has mutual aid groups.
	RES17. The caterer provides a fast service system.
	RES18. The caterer provides a good service to customers with special needs.
	RES19. When you have a problem, the app service shows a sincere interest in solving it.
Assurance (AS)	AS20. The staff have problem-solving and teamworking abilities.
	AS21. The staff relax customers and produce a leisurely dining mood.
	AS22. The staff provide you with a great deal of free catering information and assistance (context menu, cooking).
	AS23. The caterer has HACCP certification.
	AS24. The app displays product information consistent with the real products.
	AS25. The app frequently offers new catering products.
Empathy (EM)	EM26. The staff show concern for customer demands.
	EM27. The staff show empathy for strong customer satisfaction and loyalty.
	EM28. The caterer improves customer services by maximizing profits.
	EM29. Overall, you are satisfied with the products/services of this app.

Table 6. CS coefficient.

Items	ES	Rank	Items	ED	Rank
TA1. The caterer provides you with a clean parking lot.	0.6603	13	TA1. The caterer provides you with a clean parking lot.	−0.4769	19
TA2. The caterer provides you with an attractive physical environment for dining.	0.726	3	TA2. The caterer provides you with an attractive physical environment.	−0.5340	15
TA3. The caterer provides their employees with a generic uniform.	0.6396	15	TA3. The caterer provides their employees with a generic uniform.	−0.4044	26
TA4. The caterer incorporates great design elements into brand identity.	0.6433	14	TA4. The caterer incorporates great design elements into brand identity.	−0.4145	25
TA5. The caterer offers more clarity on menu labeling.	0.6050	17	TA5. The caterer offers more clarity on menu labeling.	−0.5720	12

Table 6. Cont.

Items	ES	Rank	Items	ED	Rank
TA6. The caterer creates an attractive menu card that helps the audience browse through the available options.	0.6790	11	TA6. The caterer creates an attractive menu card that helps the audience browse through the available options.	−0.4483	23
TA7. The caterer provides you with a comfortable physical environment.	0.711	4	TA7. The caterer provides you with a comfortable physical environment.	−0.5275	17
TA8. The app provides you with sufficient information.	0.739	2	TA8. The app provides you with sufficient information.	−0.4582	21
TA9. The app is easy to use.	0.705	5	TA9. The app is easy to use.	−0.6150	10
TA10. The app frequently offers mobile coupons.	0.703	6	TA10. The app frequently offers mobile coupons.	−0.3847	27
RE11. The caterer makes sure that all food comes at the right time to prevent customers from waiting any longer.	0.5425	24	RE11. The caterer makes sure that all food comes at the right time to prevent customers from waiting any longer.	−0.4654	20
RE12. The caterer is quick thinking and has problem-solving skills.	0.5434	23	RE12. The caterer is quick thinking and has problem-solving skills.	−0.7152	2
RE13. The caterer provides a menu that meets customer requirements.	0.6024	19	RE13. The caterer provides a menu that meets customer requirements.	−0.7882	1
RE14. The app provides the precise information needed.	0.4609	28	RE14. The app provides the precise information needed.	−0.6332	9
RE15. The app has met your expectations.	0.5100	27	RE15. The app has met your expectations.	−0.7030	3
RES16. The caterer has mutual aid groups.	0.5225	25	RES16. The caterer has mutual aid groups.	−0.5525	18
RES17. The caterer provides a fast service system.	0.6626	12	RES17. The caterer provides a fast service system.	−0.6006	11
RES18. The caterer provides a good service to customers with special needs.	0.700	7	RES18. The caterer provides a good service to customers with special needs.	−0.4514	22
RES19. When you have a problem, the app service shows a sincere interest in solving it.	0.5530	22	RES19. When you have a problem, the app service shows a sincere interest in solving it.	−0.6380	7
AS20. The staff have problem-solving and teamworking abilities.	0.6006	20	AS20. The staff have problem-solving and teamworking abilities.	−0.6336	8
AS21. The staff relax customers and produce a leisurely dining mood.	0.6285	16	AS21. The staff relax customers and produce a leisurely dining mood.	−0.4257	24
AS22. The staff provide you with a great deal of free catering information and assistance (context menu, cooking).	0.5750	21	AS22. The staff provide you with a great deal of free catering information and assistance (context menu, cooking).	−0.6660	4
AS23. The caterer has HACCP certification.	0.6042	18	AS23. The caterer has HACCP certification.	−0.5501	14
AS24. The app displays product information consistent with the real products.	0.5155	26	AS24. The app displays product information consistent with the real products.	−0.3773	28
AS25. The app frequently offers new catering products.	0.682	9	AS25. The app frequently offers new catering products.	−0.5630	13

Table 6. Cont.

Items	ES	Rank	Items	ED	Rank
EM26. The staff show concern for customer demands.	0.685	8	EM26. The staff show concern for customer demands.	−0.5305	16
EM27. The staff show empathy for strong customer satisfaction and loyalty.	0.6806	10	EM27. The staff show empathy for strong customer satisfaction and loyalty.	−0.6456	5
EM28. The caterer improves customer services by maximizing profits.	0.747	1	EM28. The caterer improves customer services by maximizing profits.	−0.6390	6
EM29. Overall, you are satisfied with the products/services of this app.	0.4302	29	EM29. Overall, you are satisfied with the products/services of this app.	−0.2773	29

3.5. Comparison of Kano and TOPSIS

Next, the Kano method is compared to the TOPSIS method, with Table 7 listing the results of the comparison. However, TOPSIS suffers from some disadvantages in terms of its calculation methods and results in an uncertain environment. However, based on the results, the TOPSIS method (see S^* values) does not discriminate clearly among service quality. The development steps of the TOPSIS method for the competitive benchmark were stated as follows:

Table 7. Comparative analysis of Kano and TOPSIS methods in the catering field.

Items	KANO		TOPSIS		
	Extent of Satisfaction	Extent of Dissatisfaction	$\overline{S}_i^+$	$\overline{S}_i^-$	$\overline{C}_i^*$
TA1. The caterer provides you with a clean parking lot.	0.6603	−0.4769	0.0424	0.1207	0.7401
TA2. The caterer provides you with an attractive physical environment.	0.7264	−0.5340	0.0532	0.1167	0.6867
TA3. The caterer provides their employees with a generic uniform.	0.6396	−0.4044	0.0333	0.1401	0.8081
TA4. The caterer incorporates great design elements into brand identity.	0.6433	−0.4145	0.0333	0.1373	0.8047
TA5. The caterer offers more clarity on menu labeling.	0.6050	−0.5720	0.0781	0.0847	0.5201
TA6. The caterer creates an attractive menu card that helps the audience browse through the available options.	0.6790	−0.4483	0.0314	0.1319	0.8078
TA7. The caterer provides you with a comfortable physical environment.	0.7111	−0.5275	0.0518	0.1153	0.6900
TA8. The app provides you with sufficient information.	0.7397	−0.4582	0.0274	0.1389	0.8353
TA9. The app is easy to use.	0.7050	−0.6150	0.0812	0.0933	0.5347
TA10. The app frequently offers mobile coupons.	0.7034	−0.3847	0.0132	0.1542	0.9210
RE11. The caterer makes sure that all food comes at the right time to prevent customers from waiting any longer.	0.5425	−0.4654	0.0678	0.1116	0.6222
RE12. The caterer is quick thinking and has problem-solving skills.	0.5434	−0.7152	0.1292	0.0348	0.2122
RE13. The caterer provides a menu that meets customer requirements.	0.6024	−0.7882	0.1452	0.0422	0.2250

Table 7. Cont.

Items	KANO		TOPSIS		
	Extent of Satisfaction	Extent of Dissatisfaction	$\overline{S_i^+}$	$\overline{S_i^-}$	$\overline{C_i^*}$
RE14. The app provides the precise information needed.	0.4609	−0.6332	0.1214	0.0523	0.3012
RE15. The app has met your expectations.	0.5100	−0.7030	0.1306	0.0323	0.1981
RES16. The caterer has mutual aid groups.	0.5225	−0.5225	0.0829	0.0915	0.5247
RES17. The caterer provides a fast service system.	0.6626	−0.6006	0.0794	0.0873	0.5236
RES18. The caterer provides a good service to customers with special needs.	0.7007	−0.4514	0.0286	0.1343	0.8246
RES19. When you have a problem, the app service shows a sincere interest in solving it.	0.5530	−0.6380	0.1053	0.0577	0.3539
AS20. The staff have problem-solving and teamworking abilities.	0.6006	−0.6336	0.0969	0.0667	0.4079
AS21. The staff relax customers and produce a leisurely dining mood.	0.6285	−0.4257	0.0389	0.1322	0.7727
AS22. The staff provide you with a great deal of free catering information and assistance (context menu, cooking).	0.5750	−0.6660	0.1101	0.0535	0.3269
AS23. The caterer has HACCP certification.	0.6042	−0.5501	0.0722	0.0910	0.5577
AS24. The app displays product information consistent with the real products.	0.5155	−0.3773	0.0690	0.1396	0.6694
AS25. The app frequently offers new catering products.	0.6820	−0.5630	0.0656	0.1006	0.6053
EM26. The staff show concern for customer demands.	0.6850	−0.5305	0.0549	0.1096	0.6663
EM27. The staff show empathy for strong customer satisfaction and loyalty.	0.6806	−0.6456	0.0927	0.0813	0.4671
EM28. The caterer improves customer services by maximizing profits.	0.7470	−0.6390	0.0883	0.0990	0.5285
EM29. Overall, you are satisfied with the products/services of this app.	0.7621	−0.6123	0.0561	0.0561	0.4271

(1) Establish a normalized decision matrix. Let r_{ij} denote the normalized value and x_{ij} denote the value of the corresponding element divided by the operation of its column elements, i.e., vector normalization, then:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m (x_{ij})^2}} \quad (3)$$

where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

(2) Assign the attributed weights. Let w_j be the weight of the j th attribute, $w_j \in [0, 1]$, $\sum_{j=1}^n w_j = 1$ and V_{ij} denote a weighted decision matrix:

$$V_{ij} = w_j r_{ij} \quad (4)$$

where $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

(3) Determine the ideal and negative ideal solutions. A^* (PIS) and A^- (NIS), respectively.

For DM k , the PIS and NIS are:

$$\begin{aligned} A^+ &= \left\{ \left(\max_i V_{ij} | j \in J \right), \left(\min_i V_{ij} | j \in J' \right) \right\} = \{V_1^+, V_2^+, \dots, V_j^+, \dots, V_n^+\}, \\ A^- &= \left\{ \left(\min_i V_{ij} | j \in J \right), \left(\max_i V_{ij} | j \in J' \right) \right\} = \{V_1^-, V_2^-, \dots, V_j^-, \dots, V_n^-\}, \end{aligned} \quad (5)$$

where J is associated with the benefit criteria and J' is associated with the cost criteria; $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

(4) Measure the separation distance of the i th design alternative from the PIS and NIS:

$$S_i^+ = \sqrt{\sum_{j=1}^n (V_{ij} - V_i^+)^2} \text{ and } i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (6)$$

and

$$S_i^- = \sqrt{\sum_{j=1}^n (V_{ij} - V_i^-)^2} \text{ and } i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (7)$$

(5) Calculate the relative closeness $\bar{C}_i^*$ to the ideal solution for the group:

$$\bar{C}_i^* = \frac{S_i^-}{S_i^+ + S_i^-} \quad (8)$$

where $0 \leq \bar{C}_i^* \leq 1$. The larger the index value, the better the performance of the alternative.

(6) Rank the preference order of the competitive design alternatives according to their relative closeness to the ideal solution.

Then, through aggregation by the geometric mean, the relative closeness can be calculated as illustrated in Table 8. We found that the 10th candidate is ranked first and the 29th candidate is ranked last.

Table 8. The relative closeness and rank by TOPSIS.

No.	Separation Measure of the Group		Relative Closeness	Rank
	S_i^+	S_i^-	$\bar{C}_i^*$	
1	0.0424	0.1207	0.7401	8
2	0.0532	0.1167	0.6867	10
3	0.0333	0.1401	0.8081	4
4	0.0333	0.1373	0.8047	6
5	0.0781	0.0847	0.5201	20
6	0.0314	0.1319	0.8078	5
7	0.0518	0.1153	0.6900	9
8	0.0274	0.1389	0.8353	2
9	0.0812	0.0933	0.5347	16
10	0.0132	0.1542	0.9210	1 *
11	0.0678	0.1116	0.6222	13
12	0.1292	0.0348	0.2122	27
13	0.1452	0.0422	0.2250	26
14	0.1214	0.0523	0.3012	25
15	0.1306	0.0323	0.1981	28

Table 8. Cont.

No.	Separation Measure of the Group		Relative Closeness	Rank
	$\bar{S}_i^+$	$\bar{S}_i^-$	$\bar{C}_i^*$	
16	0.0829	0.0915	0.5247	18
17	0.0794	0.0873	0.5236	19
18	0.0286	0.1343	0.8246	3
19	0.1053	0.0577	0.3539	23
20	0.0969	0.0667	0.4079	22
21	0.0389	0.1322	0.7727	7
22	0.1101	0.0535	0.3269	24
23	0.0722	0.0910	0.5577	15
24	0.0690	0.1396	0.6694	11
25	0.0656	0.1006	0.6053	14
26	0.0549	0.1096	0.6663	12
27	0.0927	0.0813	0.4671	21
28	0.0883	0.0990	0.5285	17
29	0.1213	0.0312	0.1829	29 #

Note: (1) The separation measure of the group is counted as the geometric mean of all DMs with Euclidean and vector normalization. (2) There are a total of 29 candidates for evaluation. (3) “*” and “#” mark the first and last candidate, respectively.

4. Research Framework and Implementation

4.1. Theoretical Framework

Based on the principles of TRIZ, we propose a new approach to systematic service design that comprises four main stages. The input for the method is an identified service problem. At Stage 1, the identified problem is “translated” into the language of TRIZ to provide insightful information for further problem solving. At Stage 2, the problem is structured into typical TRIZ contradictions by conducting a contradiction analysis, one of the most effective problem resolution tools. TRIZ knowledge-based principles, such as the 40 inventive principles and 4 separation principles, may then be employed to eliminate the contradictions. At Stage 3, the generated ideas are evaluated by using the unique TRIZ criteria, which is the ideal final result. The final output is a list of possible innovative conceptual solutions for the service design. We can represent the above TRIZ framework with the flow chart shown in Figure 1.

Based on the principles of TRIZ, we adapted DINESERV, introduced by [61] in 1995, as a way of determining how customers perceive the quality of the service in a mobile diner. The Kano model was used to reflect the needs of the customers in the mobile diner, while TOPSIS was developed to evaluate the service quality of the mobile diner. Then, we studied the consumer expectations of the mobile diner and found that the four dimensions had the same ranking in all segments. Listed in descending order of importance to the consumers, the dimensions are reliability, responsiveness, assurance, and empathy. The framework of catering services [61] offers an opportunity to measure the ways in which dining consumers determine which restaurants meet their quality and value standards. The 29-item DINESERV questionnaire comprises service quality standards that fall into the five categories of assurance, empathy, reliability, responsiveness, and tangibles. The food service [13,15,62,63], education service [64], health service [65–67], and tourist service [68] were investigated with the SERVQUAL survey instrument in several articles. These studies, however, complement each other well, for each emphasizes a different aspect of web apps. The authors of [61] proposed a framework for the quality of catering service that has stood the test of time. A picture of the research framework is depicted in Figure 2.

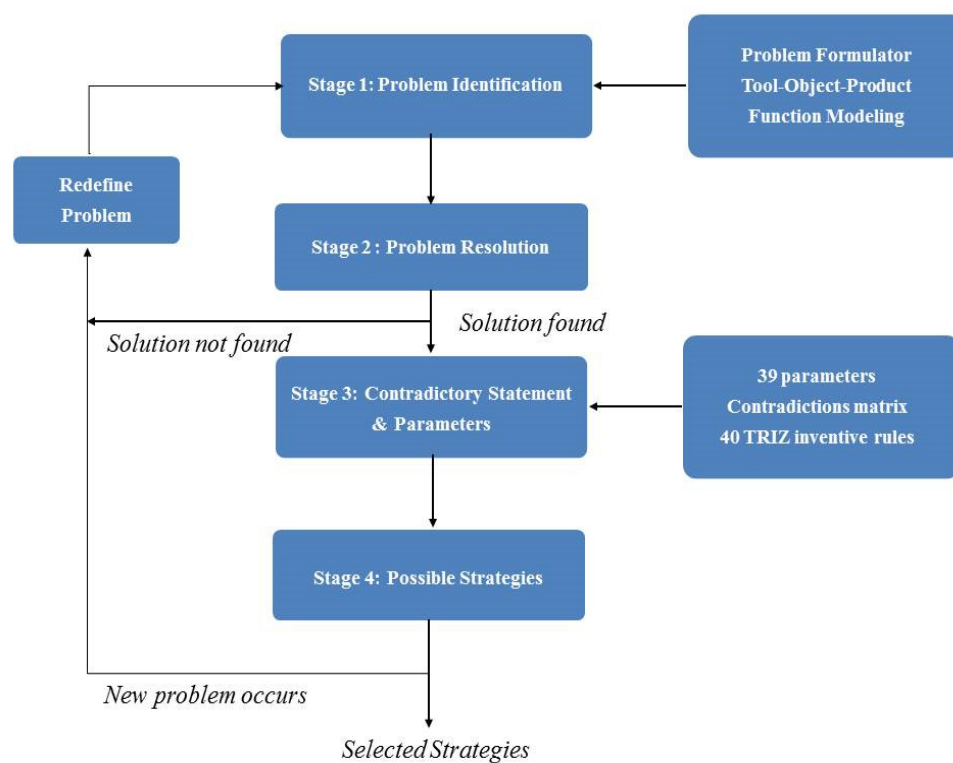


Figure 1. Modified TRIZ framework for the problem solving process in service design.

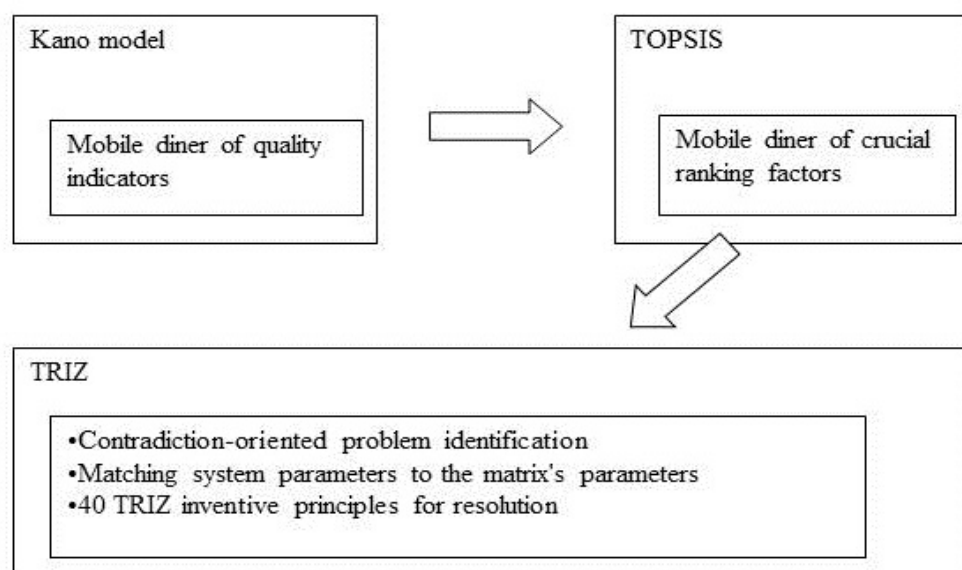


Figure 2. Research framework.

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

4.2. New Characteristics for the TRIZ Contradiction Matrix

In Table 9, a set of 13 characteristics is introduced to describe the various phenomena taking place in food product development. The suggested characteristics are complementary to the characteristics proposed by [69]. These characteristics should be helpful in

finding creative solutions to the problems encountered in the catering industry, especially for the service process, thanks to the tuning of the contradiction matrix for the specificity of the processing industries.

Table 9. Results of clarification matched with inventive principle.

Inventive Principle		Clarification
1	#01. Segmentation. #35. Transformation of the physical or chemical states of an object.	Catering system (App; Website) allows owners to understand and reach their target markets faster, more accurately, and more cost-effectively, facilitating customer retention and development.
2	#13. Inversion. #28. Replacement of a mechanical system.	The caterers hand out free food samples of a new menu. Themed evenings where guests can try the food or drink are a great way to build your brand, as this gives customers an ideal opportunity to utilize the other four senses (taste, appearance, etc.) in the customer experience.
3	#19 Partial action.	Caterers need a product content strategy. It involves understanding the needs and wants of core customer groups so products can target key customer desires and it allows a firm to predict how a product will be received within a market upon launch.
4	#01 Segmentation. #02 Extraction. #35 Transformation of the physical or chemical states of an object.	Caterers build a database for food. A web-based dietary assessment tool is an important tool for estimating food and nutrients. In the dietary record approach, each respondent must describe the foods and amounts consumed, including ingredients and cooking methods.
5	#13 Inversion. #35 Transformation of the physical or chemical states of an object.	Caterers create a SNS where a customer can share mobile coupons (m-coupons) via social network sites (SNS). The convenient functions provided by mobile SNSs increase customer satisfaction and induce a flow experience, but it can cause adverse consequences simultaneously.
6	#30 Flexible shells and thin films.	Caterers use QR codes on product packaging to cater to their mobile-first audience and foster long-term brand loyalty.
7	#32 Color changes.	Caterers offer a refrigerated display case that can be used in just about any food service establishment. The display case allows the owner to show off some creations while giving customers an easy way to make their selections.
8	#02 Extraction. #04 Asymmetry. #24 Mediator.	To guarantee high quality, caterers have established controlled, well-organized processes and service structures. For example, tangential components and sauce mixtures.
9	#28 Replacement of a mechanical system. #32 Color changes.	Check points alert employees to potential threats to the security of their systems and provides information (cooking time, residual amount, portion size).
10	#03 Local quality.	Caterers integrate risk management training and awareness into the system for improving service quality.

Table 9. Cont.

	Inventive Principle	Clarification
11	#01 Segmentation. #10 Prior action.	Caterers create market segments that, with customer needs research (also known as consumption, preference, frequency, reaction), are helpful for marketing planning.
12	#25 Self-service.	Create work practices to encourage employees to work together and openly discuss ways to improve service processes (e.g., CRM).
13	#16 Partial, overdone or excessive actions. #17 Moving to a new dimension.	Bridge the communication gap with a web app. To increase customer satisfaction, caterers provide more ways to communicate with customers.

5. Discussion and Implications

5.1. Discussion of Findings

The main problem that occurred in the catering service was low efficiency during the COVID-19 pandemic. Herein, the low efficiency of the service procedure caused the firm to be unable to meet the demand and, as a consequence, the firm needs new technology. This article demonstrates the effectiveness of novel innovation services in the TRIZ and Kano methods by using a catering app to place food orders during the COVID-19 pandemic in Taiwan. In order to solve the problem, the article aims to develop a new catering system to improve the current process of mobile catering. Our study filled the gap in the existing research that only examined consumer behavior through desktop-based online systems ([70–73]). These studies only considered a single component, either apps attributes, information determinants or restaurant-based service quality. However, the present article enhances the findings of the previous studies by providing innovation processes and designs for systems in the catering service.

5.2. Theoretical and Practical Implications

Several theoretical implications can be drawn from this article. First, the article contributes to the literature of app technology that is used in emergency situations, primarily during the COVID-19 pandemic. Further, our study was conducted in Taiwan, which is the largest app market. Second, the article adopts the pleasure arousal dominance theory to investigate the influence of app aesthetics on emotions in the context of health and safety. The findings of the study confirm the suitability of pleasure and dominance emotions in the app context. We establish the validity of studying app usage in the form of continued usage intentions instead of adoption during a crisis. We observe that continued usage intentions toward app software during a crisis such as the COVID-19 pandemic could be an outcome of the app software taking the necessary steps to reduce the risk perception among consumers.

Even businesses with traditional business models have been forced to move their operations online to some extent, in order to cater for the uncertainty in the business environment due to strict lockdowns and curfews imposed as measures to contain the spread of COVID-19. Many organizations and managers are making the transition to the app-based delivery of their products and services. The growth of digital services has increased manifold. This study offers practical solutions to the managers of food delivery companies, but the insights can be used by other app-based companies (e.g., online payment apps, streaming apps, music apps, information apps, etc.) that are looking to improve their customer retention rates.

5.3. Practicality and Impact of Innovations

The practicality of the mixed approach was assessed using a case study involving a mobile catering company in Taiwan. In the following section, we introduce a well-

established mobile catering company in Taiwan. This firm performs its own branding through its own sales channels. The caterer owns an advanced iPad POS system for ease of use, iCloud, e-receipt, inventory services, and to earn points which allows for the cooking of gaojha, bu meat, and preserved egg. The poster POS software for Windows is a cloud-based Point of Sale tablet application, which enables cafes, shops, and restaurants to manage menus, orders, and supplies quickly and efficiently. In view of the preceding discussion, the five major sets of questions to be addressed for mobile catering are as follows: (1) duly-registered catering; (2) principal place of business; (3) food hygiene for mobile catering; (4) food van modification services; (5) food van safety. We can represent the service procedure of mobile catering in Figure 3 as follows: (1) reservation; (2) order; (3) delivery order; (4) cooking; (5) meal delivery; (6) dining. However, social distancing due to the COVID-19 pandemic has reformed daily lives and consumption practices of individuals. People in social isolation or quarantine mostly think of daily intake and have to follow precautions for food intake. Customers are more concerned about food safety and delivery hygiene during the COVID-19 pandemic. In addition, many consumers have increased their usage of take-away or meal delivery services during the COVID-19 pandemic. Customers take their devices with them everywhere and adding location awareness to mobile apps offers customers a more contextual experience. The location APIs available in Google Play services facilitate the adding of location awareness to your apps with automated location tracking, wrong-side-of-the-street detection, geofencing, and activity recognition. The need to reduce crowding and queuing has forced store managers to implement regulations such as “maximum customers in store” and “the Coupons.com app”.

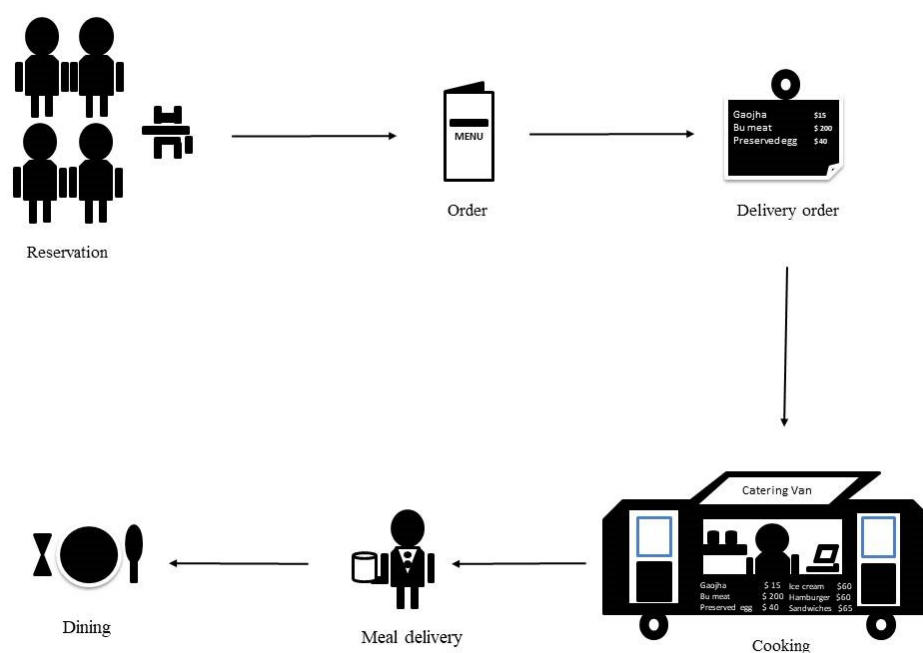


Figure 3. A service procedure of mobile catering.

The Windows-based POS system application is a program provided for the convenience and accurate working of mobile catering. Figure 4 presents the UI of the takeaway mode for mobile catering. It has an algorithm that automatically manages takeaways and orders from anywhere. Traditionally, caterers write orders on paper and then key them into the POS, which wastes valuable time. The iPad POS system does not require a fixed location as a traditional POS system does. Instead of having to key in orders at a terminal, you can take orders at the table on an iPad.



Figure 4. UI of takeaway mode for mobile catering.

5.3.1. Design of System

In recent years, more restaurants and mobile catering companies have started a digital transformation by adopting technological alternatives, such as mobile apps, e-menus, and e-payment methods, primarily motivated by cost reduction and service improvement [74]. Every individual has a personal mobile device; a more customized and personalized approach can be given based on the location, usage behavior, and interests of the user and more. As the location of the devices can be tracked using mobile apps, it becomes easy to understand the preferences of the user and thus required recommendations can be given to them, thereby enhancing the business potential. The individuals use their mobile devices for accessing their social media platforms all the time, which will help customers to understand their personalized interest and thus, more customers can be attracted. The online food ordering system market is booming worldwide. The authors of [75] studied the impact of online food delivery apps (Zomato and Swiggy) on restaurant business. Today, smartphones and tablets help customers to find a good restaurant or café nearby and that is a staple use of smartphones, in particular. The authors of [76] provided an innovative digital menu solution in the catering services in specific countries to promote better food choices. The use of mobile technology and the number of users is constantly increasing. With the ever-growing list of mobile activities, the focus is to upgrade the individual features that combine to make a modern mobile user experience. Study [11] examined which factors affect the intention of mobile application use, including ease of use, importance of others' opinions, entertainment motivations, and information seeking motivations. Study [63] attempts to combine ZMET and MEC techniques in the study of the user expectations of catering customer service apps. Previous research has shown efforts on learning and understanding functions affect user preferences of mobile apps. In this investigation we modified and customized the procedure of mobile apps.

5.3.2. Data Flow

We built a custom mobile app architecture (Azure App Service Mobile Apps) to simplify the authentication with multiple social identity providers, store data, sync the data for offline access, and send push notifications. Mobile developers write programs inside a mobile development environment using Visual Studio (PC or Mac) and Xamarin, sharing

C# code across Android, IOS, and Windows. The data processing procedure of Azure apps is described in Figure 5:

- (1) Create the mobile apps using Visual Studio and Xamarin;
- (2) Create and configure new mobile apps' backends on the Azure portal, or through Visual Studio, and configure the solution in Visual Studio to communicate with the backend;
- (3) Implement authentication through social identity providers;
- (4) Create a model-driven data structure through the app service APIs and SDK;
- (5) Implement offline sync to make the mobile apps functional without a network connection;
- (6) If you created the backend in Visual Studio, you can publish the app services directly from Visual Studio (PC or Mac);
- (7) Store the solution source code with your source control provider of choice;
- (8) Build and test the apps through the Visual Studio app center and publish it.

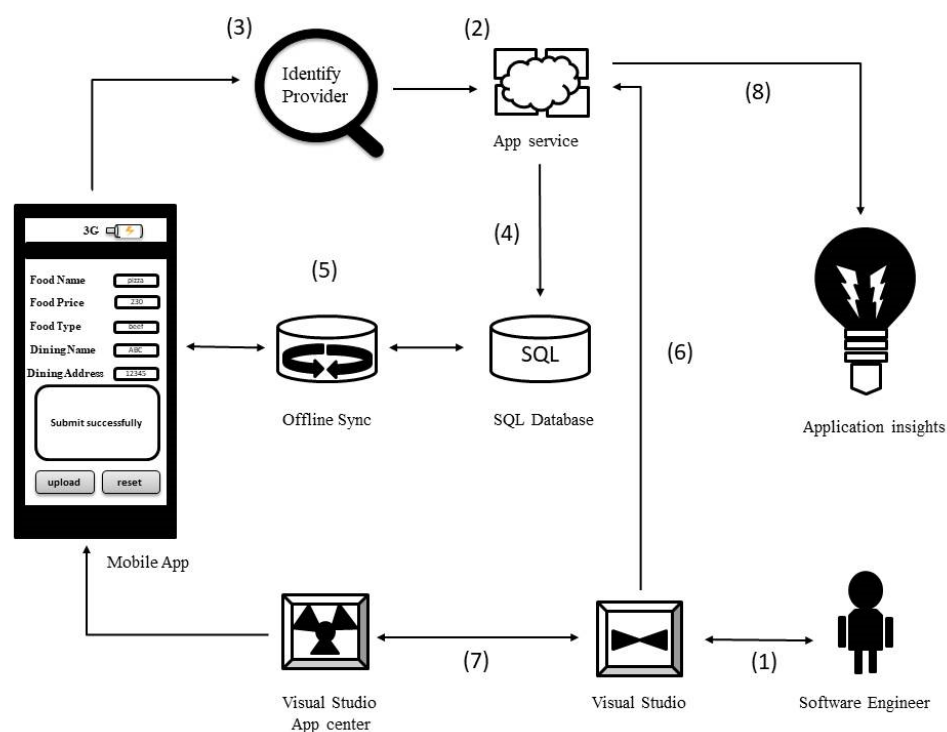


Figure 5. Data flow diagram of mobile apps.

5.4. Limitations and Further Research

Despite the large number of participants and the variety of tasks, the design of the present article is not without limitations. First, new food ordering apps (NFOAs) as an emerging online-to-offline mobile technology due to the particular situation of the COVID-19 pandemic limits the context of continued usage intentions during a food crisis. Therefore, future work will hopefully pay attention to different fields in food safety and health. Second, the findings are based on data collected through a self-reported survey in a single geography, which may limit the generalizability of the study. Future research can apply longitudinal and experimental methods to explore customer perceptions in different regions. Third, the current study utilizes the impact of the design in hardware interface. Future research therefore needs to be generalized to apply to the different app platforms, e.g., service providers and other contexts of the online-to-offline service industry.

6. Conclusions

COVID-19 has given a modest boost to online shopping in Taiwan. Taiwan's e-commerce market (pure online platform) grew in 2020 at a comparably modest pace of 16.2% to reach NTD 241.2 billion (about USD 8.6 billion), according to Ministry of Economic Affairs (MOEA). In this article, we present the results of a comparison between the TRIZ and Kano models for decision making. The five major DINESERV dimensions for implementation were tangibles, reliability, responsiveness, assurance, and empathy. The results of this article have several managerial implications regarding the improvement and development of service quality for mobile catering to meet customer expectations. Some effective strategies to improve and control the five top-priority improvement items were proposed. For example, for tangibles, what are the benefits of upgrading your hardware and software? Five of these findings are summarized from Table 7: TA10, the app frequently offers mobile coupons; TA8, the app provides you with sufficient information; RES18, the caterer provides a good service to customers with special needs; TA3, the caterer provides their employees with a generic uniform; TA6, the caterer creates an attractive menu card that helps the audience browse through the available options.

Some effective strategies to improve and control the three top-priority improvement items are summarized below. With new information technology (3GPP) overcoming the shortage of information technology workers; for example, at least these three strategies might be considered:

1. Integrated GPS navigation system.

Catering services, local restaurants and franchise owners can rest assured knowing their food delivery trucks will arrive on time to their locations with the ATTI GPS fleet tracking system. With GPS technology, customers can track your catering van in real time, giving you access to the location and activity of each delivery vehicle from your computer or mobile device.

2. Creating a platform application of SNSs (Social Networking Services).

A social networking service (SNS) is an online vehicle for creating relationships with other people who share an interest, background or real relationship. The SNS system is based on online advertising, either through targeted advertising that utilizes an individual's personal information, search habits, location or other such data, or by selling the personal information to third parties.

3. Creating a service blueprint for a mobile catering van.

Service blueprints are a critical part of the service design experience. Service blueprint design systems that could be applied to catering vans and other relevant events. Catering services appear to be a rising field, and one form of special catering business model has attracted particular attention. A service blueprint may decrease the probability of failure, help with the achievement of controlled implementation, and help to gain control of the design and management process.

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