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## Exploring the factors that drive consumers to use contactless delivery services in the context of the continued COVID-19 pandemic

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## ABSTRACT

The spread of the COVID-19 pandemic has resulted in the launch of contactless delivery services. This research integrates resource matching, service quality evaluation, and perceived value theories to explore the factors that promote the use contactless delivery services. The data was obtained through questionnaire surveys, and research hypotheses were verified through the structural equation modelling approach. With the exception of convenience, the results show that privacy, reliability, security, and flexibility have a significantly positive effect on consumers' intention to use "contactless" delivery services through consumers' perceived value. This study contributes to the literature by introducing theoretical frameworks from various paradigms and enriches the academic research on existing theoretical structure models. It also helps optimize resource allocation and realize the social environment related to coexisting with the COVID-19 pandemic.

## 1. Introduction

The COVID-19 pandemic has affected nearly all aspects of life and world economy. In order to prevent the COVID-19 pandemic spread out, various contactless epidemic prevention measures such as strict closed quarantine and pandemic prevention measures to restrict people from going out (Chen et al., 2020), maintenance of social distancing and restriction of unnecessary gatherings (Krishnamurthy, 2020; Wang et al., 2021a) have been adopted by governments. Obviously, the COVID-19 pandemic not only disrupted the supply chain but also changed consumers' behavior and a new business model, namely contactless delivery service was consequently emerged (Erjavec and Manfreda, 2022).

During the first wave of the COVID19 explosion, online sales in Poland increased by 26%, which led to an overload in the express transport sector, with the business burden particularly concentrated in the "last mile" delivery service (Milewski and Milewska, 2021). In addition, the US grocery delivery service 'Instacart' saw sales increase by nearly 500% in April 2020, and meal-kit delivery service 'Sun Basket' doubled weekly sales in the early days of the first wave of the epidemic, with demand for contactless "last-mile" delivery services increasing at a rapid pace (Gee et al., 2020). To prevent contact and infection,

contactless delivery service is one of the future provided by many companies and institutions such as foodpanda, Grab delivery service and Pizza Hut, for product distribution and delivery. Consequently, the demand for this service has increased significantly (Zhao and Bacao, 2020; Yuchen, 2020; Wang et al., 2021a; Meena and Kumar, 2022). Although it is very difficult to change people's behaviors and habits by changing the delivery method, repeating the behavior is bound to change their habits in the future (Neal et al., 2006). Thus, the contactless delivery service model significantly contributes to enabling the coexistence with COVID-19.

After the COVID-19 outbreak, the contactless model has gained attentions in the retail and logistics industry (Pantano and Vannucci, 2019; Yuen et al., 2020; Jiang et al., 2021b; Tsai and Tiwasing, 2021). Although the contactless delivery service may has risk of potential theft, damage, monetary loss or other unexpected events (Zhou et al., 2020; Osakwe et al., 2022), the promotion and use of contactless delivery services will become a common trend in the retail, takeaway, and logistics service industries. On the one hand, coexistence with COVID-19 has become inevitable in public epidemic prevention management, and the application of contactless delivery services will be particularly important (Wang et al., 2021a). On the other hand, with the continuous

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development of digital technology, the use of digital technology in the fields of e-commerce and logistics distribution has realized contactless distribution services, and the distribution capabilities supported by digital technology have further avoided the loss and wrong distribution of packages (Yuen et al., 2019). At the same time, under the requirement of maintaining social distance, contactless retail and logistics delivery adopts mobile payment methods (e.g., LINE Pay, Apple Pay, JKo Pay, Alipay and Android Pay etc.), the advantages of mobile payment services (e.g., universality, mobility, convenience and efficiency etc.) provide technical support for customers who need “cash on delivery” and “pay after inspection” (Wang et al., 2019, 2021b; Kuo, 2020). Thus, the new business model, namely contactless delivery service will dominate the retail and logistics industry in the post COVID-19 era.

It is worth noting that the last-mile distribution and the end of the supply chain are the most carbon-intensive and least energy-efficient links, and they are the main factors of carbon emissions in the whole logistics and distribution chain (Gee et al., 2020; Mucowska, 2021; Siragusa et al., 2022). However, on a global scale, the COVID19 pandemic has further driven the rapid growth in demand for last-mile delivery, and the issue of carbon emissions caused by last-mile delivery is a growing concern (Mucowska, 2021). Therefore, with the support of digital technology, promoting the use of contactless delivery services (e.g., unmanned delivery stations, new energy automated delivery vehicles, delivery robots, smart lockers and self-service cabinets, etc.) supported by technology can toward reducing the carbon footprint and improving air quality and which in turn will better achieve the goal of zero carbon emissions (Pani et al., 2020; Li et al., 2021; Gulzari et al., 2022).

In recent years, the academic community has taken the “contactless model” as the core, and has begun active academic research in the online or offline retail industry (Yuen et al., 2020; Jiang et al., 2021b; Wang et al., 2021a). At the same time, the research in the field “contactless model” of logistics delivery services has also been actively discussed and studied by scholars. Among them, the overall system of logistics distribution (e.g., Chen et al., 2020; Liu, 2020) and the content of computer intelligence innovation technology in the field of logistics distribution (e.g., Pani et al., 2020; Kim et al., 2021; Kapsler et al., 2021; Park and Chung, 2021) are the main research objects. There are also a few scholars who are conducting research on the integration of “contactless” delivery services with other scientific fields (e.g. Li et al., 2021a).

Firstly, in the study of logistics distribution routes, Chen et al. (2020) use the newly developed PEABCTS algorithm to study the ideas and specific schemes of multi-vehicle and multi-trip paths for “contactless” joint delivery services; Liu (2020)’s research is aiming at the complete design scheme of logistics distribution, and he proposes the establishment of a “circular express box” plan to realize the “contactless” delivery model. Secondly, the aspect of innovative technology in the “contactless” distribution service, Pani et al. (2020)’s research is based on “autonomous delivery robots”, and Kapsler et al. (2021)’s research is based on “autonomous delivery vehicles”, Kim et al. (2021)’s research is based on “delivery drones”, and each of them mainly conduct research on innovative technologies of computer intelligence in delivery services. Finally, in terms of the integration of “contactless” logistics and delivery services with other scientific fields, Li et al. (2021a) used the principle of elite crossing to optimize “contactless” delivery routes, followed by a proposed carbon emission model and a hybrid genetic algorithm to balance the costs and carbon emissions of “contactless” delivery services.

Synthesizing the above past literature, some studies have investigated the design of contactless delivery systems and the application of innovative autonomous devices in delivery services. However, relevant research on consumers’ intention to use contactless delivery services is still lacking and needs to be further expanded and enriched. In order to continuously promote and use contactless delivery services, and in doing so, assist human society in achieving the reduction of carbon emissions, it is necessary to explore the factors affecting the adoption of such

services from the perspective of consumers. Based on the multiple theories, namely resource matching, service quality evaluation, and perceived value theories, this study aims to empirically validate a theoretical framework model explaining consumers’ intention to adopt contactless delivery services. And will demonstrate the factors that promote the continued use of contactless delivery services by consumers.

Firstly, because resource matching theory can stimulate consumers through motivational driving force, it can reduce the perceived resources and effort required by individuals to adopt technology-supported contactless logistics services, thereby forming perceived value, which in turn affects behavioral intentions and specific behaviors (Petri and Govern, 2012; Chen et al., 2018). Secondly, service quality evaluation is the subjective judgment or perception formed by consumers on the service, that is, the personal evaluation or perceived value formed by consumers after comparing the expected utility value of service quality with its actual perceived utility value. (Jiang et al., 2021a). According to past research, consumers’ perceived value is closely related to service quality assessment (Tran, 2020; Tuncer et al., 2021). Finally, this study also uses the perceived value theory to explore the mediating role of perceived value between resource matching factors and service quality evaluation factors and adoption intentions. According to the “rational person” assumption of economics, products or services with higher perceived value are more favored and consistently used by consumers. Based on the above, this study introduces the above three theories to explore a new theoretical framework model.

The contribution of this study is twofold. Firstly, contactless delivery service has been regarded as one of the effective ways to provide consumers with high-quality and convenient express services in the post-COVID-19 era, and it is also regarded as a new idea to reduce carbon footprint (Gulzari et al., 2022). Thus, it is worth exploring the crucial factors of consumers’ intention to use contactless delivery services. Lastly, this study contributes to theory development by introducing multiple theories to better understanding the adoption of contactless service in retail and logistics sections. In particular, empirical evidence was provided to demonstrate the vital role of customer’s perceived value for contactless service adoption. Hence, this study enriches the existing literature, improves the deficiencies in the existing literature, and fills the existing gaps in the research field of contactless delivery services.

This study further conducts a theoretical review of the three cited theories. And the research framework depicting the hypothesized relationships between resource-matching attribute factors, service quality attribute factors, perceived value, and customer use intention are described in section 2. Section 3 introduces the research design, questionnaire design, measurement development, and research methods. Section 4 presents the analysis of the results, which is obtained by performing structural equation modeling. In conclusion, the analysis results are summarized and discussed. Simultaneously, the significance and limitations of this study are explained.

## 2. Theoretical background and research hypotheses

### 2.1. Theoretical framework

The well-established consumer theories such as resource matching theory, service quality evaluation theory and perceived value theory had been applied to analyze the adoption of contactless service in logistics section (Zhu et al., 2007; Yuen et al., 2019; Tsai and Tiwasing, 2021). The resource matching theory argued that consumers make the most optimal decision results when the actual resources that consumers can provide match or exceed the required perceived resources (Zhu et al., 2007). It can also reduce the resources and effort required, as perceived by individuals, in the adoption of logistics services, hence evoking consumers’ behavioral intentions and specific behaviors (Chen et al., 2018; Grimmer, 2022). Thus, when the resources that consumers can actually provide (e.g., time, money, information, and effort) match or

exceed the perceived resources required to obtain logistics services, consumers are driven by their own perceived value tendencies, hence influencing their intention to use contactless delivery services (Yuen et al., 2019; Erjavec and Manfreda, 2022). In particular, the logistics service attributes in terms of convenience, privacy, and reliability can improve customer experience and reduce effort expenditure, thereby reducing the perceived resources required to adopt them (Chen et al., 2018; Yuen et al., 2019; Tsai and Tiwasing, 2021). Thus, three variable factors of convenience, privacy, and reliability in resource matching theory were used to explore how these factors influence consumers' intention to use contactless delivery services through perceived value.

Another theoretical basis of this study is the service quality evaluation theory. Service quality is the subjective judgment or perception formed after consumers compare the expected utility of a service with the perceived utility of the actual service obtained, that is, a functional view of the service expectation-utility gap (Zeithaml et al., 2000; Jiang et al., 2021a). According to previous studies, consumers' evaluations or perceptions of service quality were closely related to the perceived value of the services and influence behavioral intentions (Yuen et al., 2019; Tang et al., 2021; Tuncer et al., 2021). Additionally, scholars had conducted numerous studies on quality factors determining the multidimensional evaluation of logistics service quality (e.g., Roy et al., 2018; Jiang et al., 2021a; Tuncer et al., 2021). In the context of the coexistence with COVID-19 scenario adopted worldwide, this study explores the relationship between service quality factors and customers' perceived value and intention to use "contactless" delivery services using safety and flexibility as research variables.

Finally, the perceived value theory forms a very important theoretical basis for this study. Perceived value is a comparative evaluation of consumers' perceived benefits and corresponding costs on the perceived utility of purchased services or products (Yuen et al., 2019; Jiang et al., 2021b). Consumers' positive or negative perceptions and evaluations of services influenced their overall assessment of the perceived utility and value of those services (Shiu et al., 2015). Perceived value is a significant predictor of consumer behavioral intentions, and rational consumers tend to choose and continue to use services that have a higher perceived value (Zauner et al., 2015; Yang et al., 2016). Perceived value in this study is reflected in three dimensions, namely, economic utility, functional utility, and social utility (Jiang et al., 2021b). Consequently, this research proposes that the unique attributes of "contactless" delivery services can enable consumers to generate perceived value, which consequently drives consumers' intentions to use "contactless" delivery services.

Table 1 summarizes the multiple theories used in this study. The resource matching, perceived value, and service quality evaluation theories can provide a theoretical foundation for this study to examine the crucial factors influencing customers' intentions to use "contactless" delivery services.

**Table 1**  
Theories and related factors influencing customers' adoption of "contactless" delivery services.

Theory	Resource matching theory	Service quality evaluation theory	Perceived value theory
<b>Paradigm</b>	Consumer psychology, motivation theory	Service Marketing	Consumer utility
<b>Theory description</b>	When the available resources owned by consumers can match or even exceed the perceived demand of the resources needed to obtain the service, a usage decision or intention is formed	Consumers compare the expected effects of a service with the perceived utility of actually obtaining the service and make subjective judgements	Consumers choose or use products and services that provide the maximum value or utility in the market
<b>Associated factors</b>	Convenience, Privacy, Reliability	Security, Flexibility	Perceived value
<b>Proposition</b>	The three variable factors of this theory may increase consumer adoption intentions of the "contactless" delivery service model.	The two variable factors of this theory may increase consumer adoption intentions of the "contactless" delivery service model.	The five characteristics of the "contactless" delivery service model may increase perceived value and thereby increase consumer adoption intentions.

## 2.2. Hypotheses development

Based on the above theories, Fig. 1 presents a conceptual model to examine the adoption of contactless delivery services. The research hypotheses were formulated as follows:

### 2.2.1. The effects of resource matching attribute factors on perceived value

**2.2.1.1. The effects of convenience on perceived value.** Convenience is the perception that consumers can save time and energy by using contactless delivery services, which is crucial for most consumers (Berry et al., 2002). Monetary (money or other tangible material assets) and non-monetary (time or energy) costs are crucial determinants of perceived value (García-Fernández et al., 2018). According to previous studies, convenience and perceived value had a positive relationship; in other words, improving convenience can reduce time and energy investment, hence increasing consumers' perceived value (Yuen et al., 2019; Aye, 2021; Mombeuil and Uhde, 2021). Therefore, this study asserts that, in the coexistence with the COVID-19 environment, the convenience of "contactless" delivery services can positively influence consumers' perceived value.

The convenience of "contactless" delivery services typically included geographic convenience, time convenience, and effort convenience (Roy et al., 2018; Shahijan et al., 2018; Yuen et al., 2019). By adopting contactless delivery services, consumers can reduce the expenditure of time and effort, hence enhancing the perceived efficiency and functional utility of the service. Additionally, from an economic point of view, the convenience of contactless delivery services can reduce time and opportunity costs, increase the time gained to complete other tasks, and improve overall quality of life (Shahijan et al., 2018). Consequently, economic and functional utilities are improved.

Moreover, geographical convenience should also be considered. In the context of the coexisting with COVID-19 scenario, the "last mile" delivery of logistics services is critical. This study asserts that by choosing a more convenient contactless delivery service method (such as using new energy automated delivery vehicle, smart locker, delivery robots, etc.), the physical delivery distance can be shortened, and the contact between people and the time that customers stay in a certain place when receiving packages can be reduced (Wang et al., 2021a). To better assist the entire society to coexist with COVID-19, it is necessary to make social contributions to support social public health management and improve social utility. Therefore, the following hypothesis was proposed.

**H1.** Convenience has a significant positive effect on consumers' perceived value.

**2.2.1.2. The effects of privacy on perceived value.** Privacy is the degree of security that consumers possess over personal information and avoid potential loss of privacy when purchasing products or using services (Mohd Suki and Mohd Suki, 2020). In this study, privacy refers to the degree of control that consumers have over their own personal and

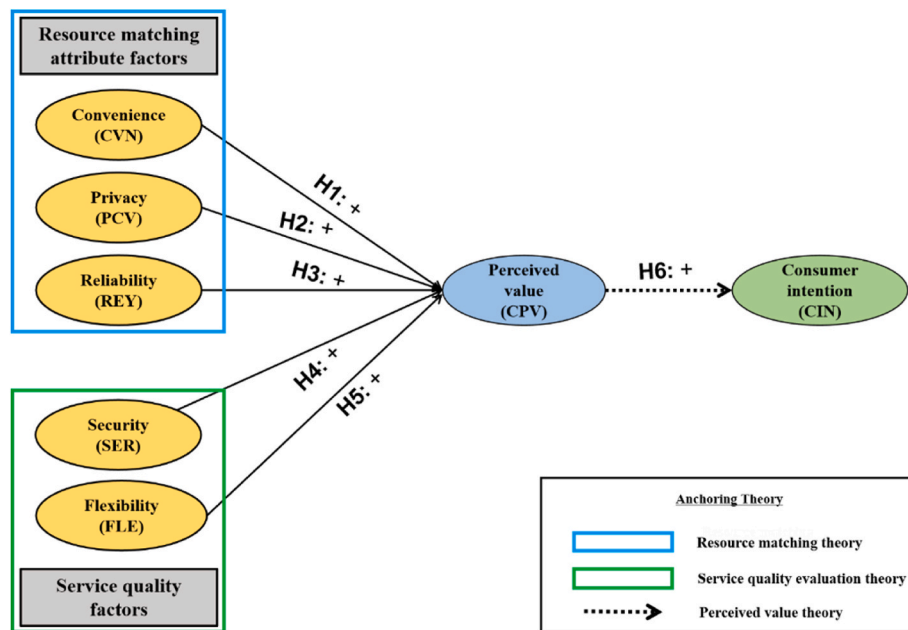


Fig. 1. The theoretical model.

family information when using “contactless” delivery services, as well as the degree of information confidentiality to avoid illegal theft and misuse of personal information by other people. Following the continuous development of various digital logistics services such as intelligent logistics distribution (e.g., smart lockers, smart robots for distribution, etc.), privacy has become one of the biggest concerns for consumers in the digital age (Barua et al., 2018; Yuen et al., 2019; Mombeuil and Uhde, 2021; Tsai and Tiwasing, 2021).

Previous studies argued that privacy factors and perceived value are positively related; in other words, the higher (lower) the privacy protection (risk), the higher the perceived value of the service to consumers (El-Haddadeh et al., 2019; Shaw and Sergueeva, 2019; Yuen et al., 2019; Mohd Suki and Mohd Suki, 2020). Therefore, in the context of this study, when consumers use “contactless” delivery services, privacy factors significantly influence their perceived value.

First, the use of contactless delivery services will prevent contact and interaction between the courier and the customer, and prevent leakage of private information like the details of the customer’s life and the contents of the package, during the delivery process (Wang et al., 2018). Therefore, the use of contactless delivery services can increase customers’ control over private information, hence providing them with functional utility. Second, the use of “contactless” delivery services can improve the comfort and security of certain special groups of people (e.g., people who suffer from social anxiety, etc.) in life, so that contactless delivery services can provide customers with functional utility. In conclusion, in the context of the digital era of Internet of Things (IoT), personal digital information is intricately bound to various intelligent service platforms; the use of contactless delivery services can improve the security of private data and digital assets information, and further create a safe environment for the protection of personal information (Wang and Lin, 2017; Yuen et al., 2019). This can enhance customers’ perception of the economic, functional, and social utility of contactless delivery services. Therefore, the following hypothesis is proposed.

**H2.** Privacy has a significant positive effect on consumers’ perceived value.

**2.2.1.3. The effects of reliability on perceived value.** Reliability is the ability of the services purchased or adopted by consumers to be executed accurately and reliably (Parasuraman et al., 1988). In the context of this

study, reliability refers to contactless delivery services that can deliver packages accurately and smoothly as required by customers and ultimately satisfy consumers’ expectations (Arshad et al., 2005). Yuen et al. (2019) demonstrated that reliability factors can improve consumers’ perceived value through the study of smart lockers. This study asserts that, in the context of the “coexistence with COVID-19” scenario, the reliability of contactless delivery services positively affects consumers’ perceived value.

On the one hand, when consumers use contactless delivery services, they focus on behavioral certainty (i.e., the reliability of the delivery service) and environmental certainty (i.e., the reliability of the delivery service environment and system model). Compared with traditional delivery services, contactless delivery services can still provide consumers with reliable delivery services (Yuen et al., 2019; Tsai and Tiwasing, 2021). This study argues that, in the context of coexistence with COVID-19, contactless delivery services can provide consumers with a sense of behavioral safety and the certainty of a stable delivery environment. At the same time, the contactless delivery service supported by digital technology can increase the accuracy of the last mile distribution, hence optimizing the carbon emission problem and realizing zero-carbon emission logistics. The reliability of “contactless” delivery services can also bring social and functional utility to customers.

On the other hand, service reliability can be understood as the customer’s perceived usefulness services (Demoulin and Djelassi, 2016; Tang et al., 2021). This study asserts that in the context of coexistence with COVID-19, the reliability of contactless delivery services enables customers to perceive the usefulness of services, hence forming consumers’ perceived value. It can create a safe environment that is free from diseases, hence reducing time costs (e.g., the time spent on handling delivery errors, potential risk of being isolated, etc.) and personal energy costs (e.g., mental stress in terms of potential risk of being infected, etc.), and help build a social environment that prevents the spread of the COVID-19 virus, to provide customers with functional, economic, and social utility. Based on this, the following hypothesis is proposed.

**H3.** Reliability has a significant positive effect on consumers’ perceived value.

## 2.2.2. The effects of service quality factors on perceived value

**2.2.2.1. The effects of security on perceived value.** In this study, we distinguish between privacy and security issues and define security as the security aspects that are related to protecting consumers and couriers from getting infected with the COVID-19 virus, from losses caused by the pandemic, and safeguarding health in the context of the coexistence with COVID-19 environment (Narteh, 2015). Prior studies had asserted that the security of contactless delivery services positively influences consumers' perceived value. Chang and Wang (2011) demonstrated that security in e-commerce services positively influences consumers' perceived value. In contrast, there may be a negative relationship between the customer's perceived risk and perceived value of contactless delivery services. Mohd Suki and Mohd Suki (2020) demonstrated that perceived security risk negatively affects the perceived value of services. Zhou et al. (2020) also noted that perceived risk was negative related to perceived satisfaction and behavioral intention. The security of contactless delivery services can provide customers with a healthier and safer logistics distribution environment, avoid the risk of COVID-19 virus infection, enable customers to use convenient express delivery services with confidence, and provide customers with functional and social utility. Therefore, this study proposes the following hypothesis:

**H4.** Security has a significant positive effect on consumers' perceived value.

**2.2.2.2. The effects of flexibility on perceived value.** Flexibility refers to the ability to adapt to foreseeable or unforeseeable changes in the environment (Young-Ybarra and Wiersema, 1999). In this study, the flexibility of contactless logistics services means that when the objective delivery conditions change, the delivery service can quickly propose solutions while maintaining the cost of customers to continue meeting customer needs (Jin and Oriaku, 2013). In the context of the coexistence with COVID-19 scenario, the flexibility of contactless delivery services is crucial.

In a changing service environment, customers hope to be able to respond to change quickly and efficiently without incurring any additional costs (time, effort, money, and performance) (Brozovic et al., 2016; Buraczyńska and Majerek, 2021). Additionally, the perceived value of services can be improved through the flexibility (Childers et al., 2001; Teo et al., 2003). Brozovic et al. (2016) confirmed in their respective studies that flexibility in product or service offerings plays a positive influential role in creating perceived value for customers. Hence, this study asserts that the flexibility of "contactless" delivery services will positively influence consumers' perceived value.

The contactless delivery service can flexibly respond to the distribution obstacles caused by changes in the epidemic prevention policy, help prevent the potential hidden dangers caused by coexistence with COVID-19 and relieve mental stress and psychological burden. Ultimately, the flexibility of "contactless" delivery services can help consumers adapt to changes in epidemic prevention policies and play a subsidiary role in public health which in turn create economic, functional, and social benefits to consumers. Notably, the flexibility of contactless delivery services based on digital technology can ensure the quality of service while achieving energy-saving and emission-reducing zero-carbon emission logistics, which can further bring optimal social utility. Thus, this study proposes the following hypothesis:

**H5.** Flexibility has a significant positive effect on consumers' perceived value.

## 2.2.3. The effects of perceived value on consumer intention

Zeithaml (1988) defined perceived value as a free economic person's overall evaluation of product utility based on the benefits obtained and costs paid. Existing research clearly shows that consumers' perceived

value can influence behavioral intentions, and this has become a central influencing factor of consumer behavior in various fields (Zauner et al., 2015; Yang et al., 2016; Yuen et al., 2019; Jiang et al., 2021b). Yang et al. (2016), Vishwakarma et al. (2020), and Jiang et al. (2021b) asserted that the perceived value had a significantly positive effect on consumers' intentions to use virtual reality technology or augmented reality applications. In the context of this research, consumers obtained economic, functional, and social utility through contactless logistics services, forming perceived value, and thereby enabling consumer intention to use contactless logistics services. Thus, this study proposes the following hypothesis:

**H6.** Customers' perceived value has a significant positive effect on consumer intention.

Perceived value has also played as a mediating role between influencing factors and consumer intention (Molinillo et al., 2021; Kim et al., 2023). Yuen et al. (2019) showed that the influence of resource-matching attribute factors on consumers' intention to use smart lockers in logistics distribution is indirectly affected by perceived value. Charton-Vachet et al. (2020) asserted that consumers' purchase intention of regional products is mediated by perceived value of regional products. Molinillo et al. (2021) pointed out that perceived value mediated the association between environmental stimuli and consumer response in Social commerce. Kim et al. (2023) found that perceived value of a brand mediated the relationship between Instagram advertisements and behavioral intentions. Accordingly, based on perceived value theory, this study proposes the following hypothesis:

**H7.** Customers' perceived value mediates the relationship between influencing factors and consumer intention.

## 3. Methodology

### 3.1. Questionnaire design and measures

This study referred to previous literature and created the measurement scale needed for the survey. As shown in Table 2, each primary structure is composed of multiple secondary projects; the survey questionnaire used the 7-point Likert scale ranging from 1 (very little extent) to 7 (very great extent).

### 3.2. Survey design and administration

Owing to the COVID-19 pandemic, an online survey was conducted to collect research data. The questionnaire was administered by a professional survey company. The company's online panellists were invited to participate in the survey. As a common practice of the company, a few panels were mixed to ensure a good representation of the general population. The survey was soft-launched for three days to pilot-test the accuracy of the questionnaire. Subsequently, the full-scale survey was implemented, and the targeted sample size was achieved within 30 days. The study finally used 255 valid samples after excluding respondents who had not used "contactless" delivery services and poor samples. This study explains "contactless" delivery services in the survey materials, and respondents' use of new energy automated delivery vehicles, unmanned express stations, smart lockers and self-collection lockers all fall into the category of contactless delivery services. Noteworthy, the company rewards their panellists based on their profiles (e.g., past participation record and area of expertise). The rewards may take the form of monetary compensations or non-monetary credits such as flight mileages. Thus, the received incentives vary from participant to participant. As pre-specified in the survey agreement, we obtained a relatively balanced. Table 3 presents the sociodemographic characteristics of the participants.

Table 3 clearly shows that more females (75.69%) than males (24.21%) participated in the survey. The respondents aged 20–29 accounted for the largest number of respondents (67.89%). In terms of

**Table 2**  
Constructs and measurement items.

Construct	Measurement items	Adapted source
Convenience (CVN)	CVN1. Using contactless delivery services is convenient for me. CVN2. Using contactless delivery services makes my life easier. CVN3. Using contactless delivery services saves me time to worry, and I can collect express delivery when time is convenient. CVN4. Using contactless delivery services saves me a lot of effort.	Collier et al. (2014); Yuen et al. (2019)
Privacy (PCV)	PCV1. I feel safe while using contactless distribution mode. PCV2. I think that the use of contactless distribution mode does not improve the probability of my personal data being used for other purposes. PCV3. I assume using contactless distribution mode would not result in a lack of privacy for me because my personal details would be handled confidentially. PCV4. I feel that using contactless distribution mode will not compromise the privacy of my personal information. PCV5. It is safe offering my information when using the contactless distribution mode.	Featherman et al. (2010); Wells et al. (2010); Barua et al. (2018)
Reliability (REY)	REY1. I can rely on contactless distribution mode to purchase my commodity reliably. REY2. I believe that contactless distribution mode will not increase the errors by using the current technology. REY3. I believe contactless distribution mode is very reliable. REY4. I can rely on customer distribution mode that provides services I have used.	Demoulin and Djelassi (2016); Barua et al. (2018)
Security (SER)	SER1. I do not fear for my health while using the contactless distribution mode. SER2. Contactless distribution mode will protect the health of the courier. SER3. Contactless distribution mode will protect the customer and courier from getting infected by the COVID-19 virus.	Suh and Han (2003)
Flexibility (FLE)	FLE1. Contactless delivery companies have handled my complaints on time. FLE2. Problems are tackled efficiently when using the contactless distribution mode FLE3. Contactless delivery companies quickly respond to instances of service breakdown when using the contactless distribution mode.	Young-Ybarra and Wiersema (1999)
Customer Perceived Value (CPV)	CPV1. I enjoyed participating in the contactless distribution mode. CPV2. Participating in the contactless distribution mode helps me get adequate service quality. CPV3. Participating in the contactless distribution mode helps me get more customized service.	Wells et al. (2010)

**Table 2 (continued)**

Construct	Measurement items	Adapted source
	CPV4. I feel intelligent when using the contactless distribution mode to receive my commodities. CPV5. The contactless distribution mode has increased the effectiveness of online shopping.	
Customer Intention (CIN)	CIN1. I will use contactless distribution mode to receive my online shopping purchases next time. CIN2. The contactless distribution mode will be my first choice while shopping online in future. CIN3. I will encourage my friends to use the contactless distribution mode. CIN4. I will tell my friends the advantages about contactless distribution.	Young-Ybarra and Wiersema (1999)

**Table 3**  
Respondents' information.

Characteristics	Items	Frequency (N = 255)	Percentage (%)
<b>Gender</b>	Male	62	24.31
	Female	193	75.69
<b>Age</b>	<19 years	18	7.06
	20–29 years	173	67.84
	30–39 years	35	13.73
	40–49 years	12	4.71
	≥50 years	17	6.67
<b>Place</b>	Home	153	60.00
	Office	25	9.80
	Building	11	4.31
	School	39	15.29
	Other	27	10.59
<b>Education level</b>	High school	29	11.37
	Three-year college	30	11.76
	Undergraduate/Graduate	147	57.65
	Master degree and above	43	16.86
	All of the above	6	2.35
<b>Occupation</b>	Student	96	37.65
	Office worker	72	28.24
	Unemployed	12	4.70
	Freelance or other	75	29.41
<b>Income (monthly) (US\$)</b>	<1,000	106	41.57
	1000–1500	58	22.75
	1500–3000	63	24.71
	3000–5000	20	7.84
	>5000	8	3.14

education level, 86.27% of the respondents had received a college and university education or above. In terms of occupational composition, 57.65% of the respondents had work occupations. In conclusion, respondents with a monthly income of less than \$ 1,000 accounted for the highest proportion (41.57%), and only 10% of the respondents had a monthly income of \$3,000 and above.

Respondents were also asked to provide the information about their basic use of contactless delivery services. More than 2/3 of the respondents in the sample used in this study used contactless delivery services in the food and clothing categories. More than 70% of respondents use contactless delivery services every 3 days or so, 60% of respondents are used to using contactless delivery services at home, and more than 25% of respondents prefer to use contactless delivery services in the workplace or at school. It is important to note that the survey

findings can be endorsed reliable since all respondents had the experiences of using contactless delivery services in their daily life.

The questionnaire method used in this study may cause non-response bias. The method used in this study is to compare the responses of early and late respondents, that is, late respondents are not likely to respond, so they tend to exhibit non-respondent characteristics (Armstrong and Overton, 1977). According to the total time from the respondent receiving the invitation to completing the questionnaire, the data set is divided into two groups (i.e. early and late respondents). Subsequently, the mean value of each construct was calculated, and an independent *t*-test was used to compare the both groups. The results were not significant ( $p > 0.05$ ). Hence, non-response bias is not a key problem.

Since the survey of the data collected in this study is perceptual in nature, common method bias may be a problem. Therefore, Harman's single factor test is conducted (Podsakoff et al., 2003). The results show that the variance of the single factor model only accounts for 36.6% of all indicators. Therefore, common method bias is not a major problem.

### 3.3. Research method

This study followed the recommendations of Anderson and Gerbing (1988), Alzahrani et al. (2012) and Hair et al. (2012), using structural equation modelling (SEM) to test the hypothesis. Structural equation modeling (SEM) is the most appropriate technique for reliability, validity and hypothesis testing using data collected from surveys (Jiang et al., 2021a).

The SEM employed in this study is based on the Covariance-based technique (CB-SEM), which is suitable for studies using survey data to validate theory-based models (Astrachan et al., 2014). CB-SEM shows the modeled measurement error variance/covariance structure, and CB-SEM does not suffer from the problem of producing biased parameter estimates (David et al., 2011). In addition, CB-SEM utilizes chi-square to determine the difference between the observed covariance matrix and the implied covariance matrix and can provide a variety of reliable goodness-of-fit indices using a minimum sample size of 200 data, enabling robustness strict requirements for various analyses, making it more suitable for confirmatory studies (Astrachan et al., 2014; Jiang et al., 2021b). Thereafter, following the research recommendations of Hair et al. (2010), SEM with confirmatory factor analysis (CFA) was used to verify the measurement model and examine whether the research hypothesis was accepted.

According to the recommendations of Kline (1998), the use of more than 200 samples meets the data requirements of structural equation analysis. Moreover, when the sample size is greater than 200, the stability of SEM analysis will not be affected (Wang et al., 2018). In addition, this study conducted a statistical power analysis based on the recommendations made by Cohen (2013) and Westland (2010) to determine the minimum sample size required to avoid type II statistical errors ( $\beta$ ). Where  $\beta$  is the false rejection of a true significant effect. The required power ( $1 - \beta$ ) and Alpha value ( $\alpha$ ) are usually 0.80 and 0.05, respectively. The number of latent and observable variables in this study was 7 and 25, respectively. Based on this information, the minimum sample sizes required for significant effect sizes of 0.3 and 0.5, respectively, were calculated to be 170, and 42, respectively. Therefore, the current sample size ( $n = 255$ ) of this study is able to detect effect sizes of about 0.3 which is quite common in behavioural intention studies.

Moreover, SEM can handle more complex model structures such as non-normality and multicollinearity (Kursunoglu and Onder, 2019; Davvetas et al., 2020). The corresponding situation can be learned through the content of Table 5. Due to prudential consideration, this study additionally examined the issue of multicollinearity. Through analysis, all variance inflation factor (VIF) were significantly smaller than the threshold of 10 (i.e., tolerance was greater than the threshold of 0.1). Therefore, there is no problem of multicollinearity between structures and items in this study.

**Table 4**  
Confirmatory factor analysis and composite reliability.

Factor	Item	$\Lambda$	AVE	CR	Cronbach's $\alpha$
Convenience (CVN)	CVN1	0.872	0.756	0.925	0.924
	CVN2	0.922			
	CVN3	0.847			
	CVN4	0.834			
Privacy (PCV)	PCV1	0.752	0.73	0.931	0.929
	PCV2	0.861			
	PCV3	0.893			
	PCV4	0.865			
	PCV5	0.894			
Reliability (REY)	REY1	0.839	0.731	0.915	0.914
	REY2	0.779			
	REY3	0.901			
	REY5	0.892			
Security (SER)	SER1	0.853	0.733	0.892	0.891
	SER2	0.884			
	SER3	0.831			
Flexibility (FLE)	FLE1	0.847	0.701	0.875	0.876
	FLE2	0.868			
	FLE3	0.801			
Perceived value (CPV)	CPV1	0.869	0.691	0.918	0.918
	CPV2	0.837			
	CPV3	0.840			
	CPV4	0.826			
	CPV5	0.784			
Consumer intention (CIN)	CIN1	0.839	0.693	0.900	0.900
	CIN2	0.788			
	CIN3	0.848			
	CIN4	0.864			

Note:  $\chi^2 = 374.703$ ,  $df = 173$ ,  $\chi^2/df = 2.166$ , CFI = 0.960; TLI = 0.951; RMSEA = 0.068; SRMR = 0.035.

**Table 5**  
AVE, correlations, and squared correlations of the constructs.

	CVN	PCY	REY	CPY	SER	FLE	CIN
CVN	<b>0.87<sup>a</sup></b>	<b>0.50<sup>c</sup></b>	0.53	0.44	0.42	0.30	0.46
PCY	<b>0.71<sup>b</sup></b>	<b>0.86</b>	0.53	0.46	0.42	0.32	0.52
REY	0.73	0.73	<b>0.86</b>	0.61	0.53	0.48	0.53
CPY	0.66	0.68	0.78	<b>0.83</b>	0.56	0.61	0.64
SER	0.65	0.65	0.73	0.75	<b>0.86</b>	0.46	0.58
FLE	0.55	0.57	0.69	0.78	0.68	<b>0.84</b>	0.55
CIN	0.68	0.72	0.73	0.80	0.76	0.74	<b>0.83</b>

Note.

<sup>a</sup> bolded values along the main diagonal are square root of the AVEs.

<sup>b</sup> below the main diagonal are correlations between constructs.

<sup>c</sup> above the main diagonal are squared correlations between constructs.

## 4. Results and discussion

### 4.1. Measurement model analysis

Following Anderson and Gerbing (1988), confirmatory factor analysis was firstly used to evaluate the fit, reliability, and validity of the measurement model. Table 4 shows the detailed fitting indices obtained from the analysis.

Table 4 clearly shows that Cronbach's  $\alpha$  values are all above the required threshold of 0.70, as proposed by Bagozzi et al. (1981), and the factor loadings ( $\lambda$ ) and composite reliability (CRs) of the structures are above the threshold values of 0.70 and 0.80, as recommended by Hair et al. (2010). This demonstrated the reliability of the measurement items. Additionally, the fitting indicators at the bottom of Table 4 show that the comparative fit index (CFI) and Tucker–Lewis index (TLI) of this study are both greater than 0.90, the standardized root mean square residual (SRMR) is less than 0.05, and the root mean square error of approximation (RMSEA) is less than 0.08, all of which meet the standard



threshold requirements proposed by Hu and Bentler (1999). Therefore, the measurement structure used in this study has good model fit.

The validity of the measurement model in this study was assessed using convergent and discriminant validity. First, according to Table 4, all factor loadings were greater than 0.7, and were significant at the 0.05 level. In addition, the average variance extracted (AVE) in this study meets the threshold standard (AVE > 0.5) proposed by Fornell and Larcker (1981), providing satisfactory evidence for convergent validity. Second, Table 5 shows that the main diagonal is the square root of the AVE of each structure, and that the correlation coefficient and the square correlation between the two structures are shown below and above the diagonal. Table 5 clearly shows that the square root of AVE of each structure is always greater than its correlation with other structures. Therefore, the various structures in this study differ, and the discriminative validity of the measurement model is effective. Generally, the measurement model had a good degree of fit, and the measurement items were effective and reliable.

4.2. Structural model analysis

Once the measurement model was verified by validity and reliability tests, a SEM approach was performed to test the hypothesized relationships. Fig. 2 shows that the estimated structural model yielded a good fit with the indices of CFI = 0.94, TLI = 0.93, NFI = 0.93, NNFI = 0.95, both of which are greater than 0.90. Moreover, absolute fit indices, namely, RMSEA (value = 0.07) and SRMR (value = 0.04) were well below the recommended cut-off value of 0.08. The squared multiple correlations (R<sup>2</sup>) between consumer perceived value and consumer use intention were 0.912 and 0.843, respectively. These values were all greater than 0.5, highlighting the explanatory power of the structural model designed in this study.

The results of hypothesis testing obtained from the SEM analysis are shown in Fig. 2. Among the three factors associated with resource matching theory, the privacy (β = 0.160, p < 0.05) and reliability (β = 0.279, p < 0.05) factors of contactless delivery services have significantly positive effects on the perceived value of consumers. However, the convenience (β = 0.029, p > 0.05) of contactless delivery services insignificantly affects consumers' perceived value. Therefore, as shown in Table 6, hypotheses H2 and H3 are accepted, and hypothesis H1 is rejected in this study. Moreover, the security (β = 0.185, p < 0.05) and flexibility (β = 0.405, p < 0.05) of service quality evaluation factors have a significantly positive effect on consumers' perceived value.

Table 6 Results of hypotheses testing.

Hypotheses		β	Results
H1	Convenience → Perceived value	0.029	rejected
H2	Privacy → Perceived value	0.160***	supported
H3	Reliability → Perceived value	0.279***	supported
H4	Security → Perceived value	0.185***	supported
H5	Flexibility → Perceived value	0.405***	supported
H6	Perceived value → Customer intention	0.918***	supported

Note: \*\*\*p < 0.05.

Therefore, the research hypotheses H4 and H5 are accepted. These variables explain 91.2% of the variance in consumer-perceived value (R<sup>2</sup> = 0.912). Finally, the perceived value of consumption of contactless delivery services has a significantly positive effect on consumers' intention to use (β = 0.918, p < 0.05). Thus, Hypothesis H6 is supported, and the consumer-perceived value of contactless delivery services explains 84.3% of the variance in consumer intentions (R<sup>2</sup> = 0.843).

Further to examine the mediating effect of perceive value on the relationship between various influencing factors and customers' intentions, a nested model (a partial mediation model) that included the direct influence paths of influencing factors on intentions was conducted in this study. Finally, the mediating model (Fig. 3) showed an adequate model fit with the indices of γ<sup>2</sup>/df = 1.995, CFI = 0.962, TLI = 0.954, SRMR = 0.036, and RMSEA = 0.066. The results indicated that the direct effects of reliability and security on customer intention were not found in this study. Hence, there is evidence that perceived value fully mediates the relationship between reliability and customer intention as well as between security and customer intention (Baron and Kenny, 1986). On the other hand, since privacy and flexibility had significant positive impact on customers' intention, perceived value partially mediates the relationship between privacy and customer intention as well as between flexibility and customer intention. Thus, hypothesis H7 is partially supported.

4.3. Discussion

The results conclude that the privacy and reliability of contactless delivery services have a significantly positive effect on consumers' perceived value whereas the impact of convenience of contactless delivery services on consumers' perceived value was not found in this study. Therefore, hypotheses H2 and H3 are accepted and hypothesis H1

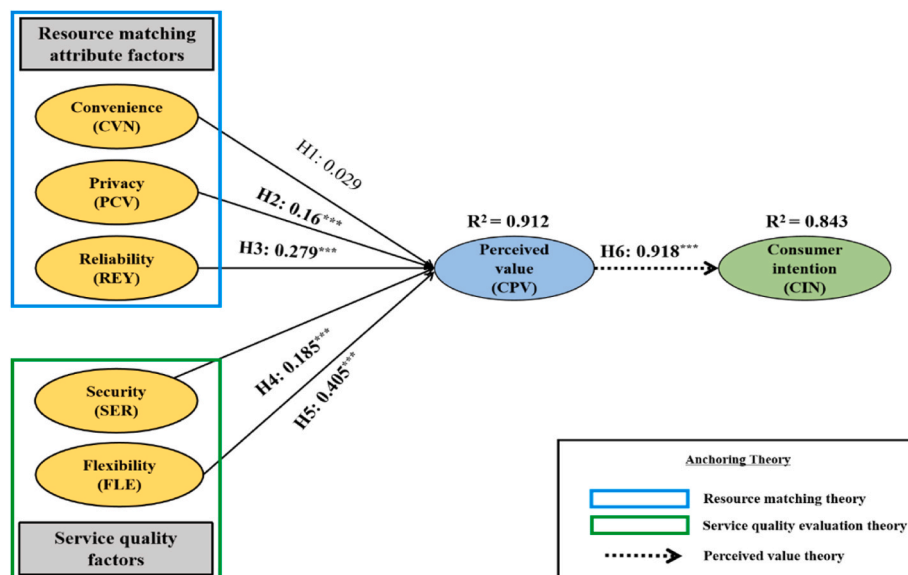


Fig. 2. Parameter estimation of theoretical model.

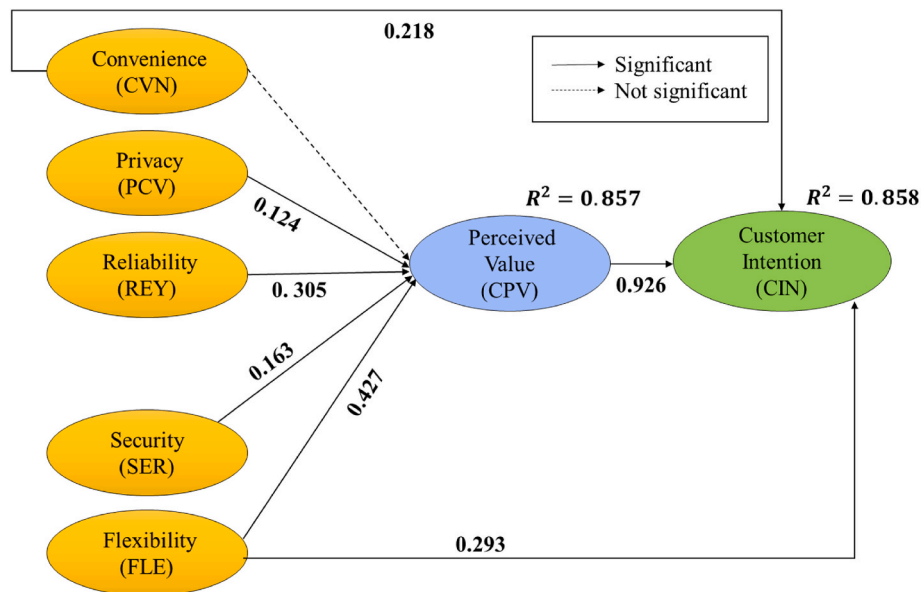


Fig. 3. The mediating model.

is rejected.

On the one hand, the convenience of contactless delivery services insignificantly affects consumers' perceived value. This result is consistent with that obtained by Collier et al. (2014). Collier et al. (2014) mentioned that, for private-oriented services, convenience factors do not have a close and significant relationship with the perceived value created by utilitarian utility. In this study, the consumer-perceived value of contactless delivery services emphasizes the perceived value caused by utilitarian utility, which can be said to be the functional utility of reducing personal time and effort expenditure, the economic utility of reducing time and opportunity costs, and the social utility of directly or indirectly assisting in pandemic control by avoiding contact between people.

On the other hand, the privacy offered by, and reliability of contactless delivery services have a significantly positive effect on consumers' perceived value, which is similar to El-Haddadeh et al. (2019), Shaw and Sergueeva (2019), Yuen et al. (2019) and Tsai and Tiwasing (2021) and is consistent with the results put forward by the present research. First, the privacy offered by contactless delivery services can prevent the leakage of private information, such as the details of the customer's life and the contents of the purchase. Simultaneously, contactless delivery services can provide a sense of comfort and security for people who are socially afraid, people who are extremely sensitive to privacy risks, and people who do not like or are inconvenienced by face-to-face contact and interaction. Additionally, it can create a safe and secure social environment for the data security of customers' personal and family member information and the security of digital assets, hence providing customers with functional and social benefits. Second, in the context of the trend of coexistence with COVID-19, the reliability of contactless delivery services can enable customers to obtain a sense of security and stability. This reduces the additional expenditures of time and personal effort, creates a safe environment from virus threats, and helps create a social environment that prevents the spread of viruses, and provides customers with functional, economic, and social utility.

Secondly, the study verifies the relationship between security and flexibility in service quality factors and consumers' perceived value of contactless delivery services. The security and flexibility of contactless delivery services have a significantly positive effect on the perceived value of consumers. Therefore, research hypotheses H4 and H5 are supported.

This result is consistent with the viewpoints proposed by Chang and

Wang (2011) and Brozovic et al. (2016). First, the security of contactless delivery services can prevent the risk of being infected with COVID-19, provide customers with a healthy and safe logistics environment, and allow customers to use delivery services without worries, hence providing customers with utility and social utility. Second, the flexibility of the contactless delivery service ensures that customers do not lose more time, effort, money and service performance, and that they receive the same quality of delivery services, avoiding delivery barriers and service problems caused by changes in epidemic control policies. Simultaneously, it can significantly reduce the mental pressure and psychological burden of consumers in the environment of coexistence with COVID-19, and be beneficial in the implementation of public anti-pandemic policies. These provide economic, functional, and social utility to consumers.

Thirdly, this study demonstrates the mediating role of perceived value between influencing factors and customer intention. The finding is consistent with prior studies (Yuen et al., 2019; Molinillo et al., 2021; Kim et al., 2023) and implies that the providing of contactless delivery services with privacy, reliability, security, and flexibility will increase customers' perceived value and which in turn increase their intentions to adopt contactless delivery service.

Fourthly, the findings suggest that the perceived value of contactless delivery services has a significantly positive effect on consumers' intention to use. Consumers' perceived value plays an intermediary role between the influencing relationship of resource matching attribute factors and service quality factors on consumer use intentions of contactless delivery services.

Finally, based on the existing theories, this research establishes a new theoretical framework model, and through empirical analysis demonstrates the influencing factors that promote consumers to continue to use contactless delivery services. And, according to past research, the "contactless" delivery service supported by digital technology can reduce the carbon emission problems caused by the last mile delivery, wrong distribution, lost packages, and so on (Yuen et al., 2019; Pani et al., 2020; Li et al., 2021; Gulzari et al., 2022). Therefore, this study believes that through the rational use of these influencing factors, the continuous adoption of "contactless" distribution services can be further promoted, and then promote the development of zero-carbon logistics in the process, and it also provides a new reference scheme for assisting human society to reduce carbon emissions and which in turn improve air quality.

## 5. Conclusion

This study asserts that the aggressive adoption of contactless delivery services in retail, food delivery, and all other industries involved in logistics and delivery services will become a general trend in the market. At the same time, countries worldwide have generally adopted the coexistence with COVID-19 scenario. Moreover, this market trend is further growing rapidly. Based on this, academia and industry have also started discussions and research on the realization of contactless delivery services and zero carbon emission logistics through digital technology. In this context, this study introduces resource matching, service quality evaluation, and perceived value theories to verify the relationship between resource matching attribute factors and service quality factors, and the perceived value and intention to use of contactless delivery services. This will help to understand the influencing factors that promote consumer acceptance of contactless delivery services and provide a richer and more diverse reference scheme for further promoting contactless delivery services supported by digital technology. As a result, it will provide new thinking directions for reducing carbon footprint and assisting in the realization of zero-carbon emissions logistics.

### 5.1. Academic and practical implications

First, this study applies resource matching, service quality evaluation, and perceived value theories to improve the existing research and enrich academic research on theoretical structural models.

Most of the research is focused on logistics and distribution systems (Chen et al., 2020; Liu, 2020), innovative technologies used in logistics and distribution (Pani et al., 2020; Kim et al., 2021; Kapser et al., 2021), and the integration of contactless delivery services with other scientific fields (Prassida and Hsu, 2022). There are few studies on consumers' use intention and behavior with respect to contactless delivery services. Furthermore, the influencing factors used in some previous studies are not based on a mature theoretical background, but simply refer to the factors that have been used in the past literature as an empirical basis to form a research model. This research takes consumers' use of technology-supported contactless delivery services as the research topic, from the perspective of consumers themselves, introduces three theories to form a new theoretical framework model and conducts empirical research. This expands the research on the theoretical structure model and enriches the theoretical framework research in the field of logistics and distribution services.

Second, this study considers perceived propensity stimuli and motivational drives as instinctive triggers of consumer behavior (Petri and Govern, 2012; Chen et al., 2018), then, three theories are introduced to explore the influencing factors of consumers' willingness to adopt contactless delivery services. That is, through the empirical analysis of this research, the nomological relationship between the determinants and the willingness of consumers to use contactless delivery services is determined, and the theoretical logic between the influencing factors is further sorted out.

The results of this study can confirm that privacy, reliability, security and flexibility can increase the investment of perceived value, and perceived value is an important reason for consumers' willingness to adopt contactless delivery services. This finding is consistent with core principles of consumer behavior and motivation research. On the one hand, in the threatening environment of the COVID19 pandemic, consumers, as "rational people" in economics, their behavioral intentions mainly depend on the evaluation of the costs and benefits of existing services. When consumers are stimulated by the perception of external environmental threats and the driving force that needs to meet the real needs of basic normal life, the privacy protection and reliability characteristics of technology-supported contactless delivery services can bring consumers more perceived benefits, thereby increasing perceived value, and finally adopting contactless delivery services has become a

behavioral strategy for coping with threats and addressing the needs of daily life. On the other hand, consumers will form a subjective judgment or perception tendency after receiving the service, so as to compare the cost of receiving the service with the actual perceived benefit, and then form the individual's perceived value of the service. That is to say, what can affect the perceived value is the subjective judgment and perceived tendency (ie, service quality) of consumers (Tran, 2020; Tuncer et al., 2021). Enables the benefits and costs of adopting the service to be measured based on the evaluation of the relevant characteristic attributes. This study means the further clarification and improvement of the theoretical level, and further combs the theoretical relationship between the influencing factors. Namely, resource matching theory and quality evaluation theory can be regarded as the forerunners of perceived value theory. These theories directly explain consumers' intention to use technology-enabled contactless delivery services. Based on this, this study provides a theoretical-level contribution for further empirical research in the future. It also provides a reference for empirical research on the continued promotion of technology-enabled contactless delivery services after the end of the COVID19 pandemic.

Finally, this study combines the characteristic attributes of technology-supported contactless delivery services with the results of previous literature and proposes ideas and suggestions for reducing logistics carbon emissions and assisting in the realization of "zero carbon emissions". This study concludes that the rational use of the influencing factors identified and described in this study to promote the sustainable adoption of technology-supported contactless delivery services by consumers will help solve the problem of carbon emissions in the "last mile" logistics and help promote the realization of "zero carbon emission" logistics, and further assist human society to achieve the goal of "zero carbon emission". The research thinking and conceptual direction proposed in this study will provide new academic perspectives and valuable literature references for cross-empirical research between the field of contactless logistics services and the field of carbon emissions after the COVID19 pandemic is completely over.

This study also has practical significance. As the world's cross-border trade restarts, it has become an inevitable trend for countries to adopt the "coexistence with COVID-19" scenario to begin the process of economic recovery. However, COVID-19 continues to mutate and spread globally. In this context, first, this study provides a new reference for the promotion of continued access to safe and secure logistics and delivery services for consumers, and also supports the literature that promotes a safe delivery environment that adheres to the idea of "coexisting with COVID-19."

Second, this study provides a reference for decision-making on the mode of operation and optimal allocation of resources for logistics and distribution companies operating contactless delivery services. At the same time, this study provides a new reference for logistics and distribution companies to promote the use of contactless delivery services to consumers and provide consumers with better-quality logistics and delivery services.

Additionally, when introducing innovative technology-supported "contactless" delivery services, the technical capabilities for the protection of consumers' privacy should be enhanced. Moreover, companies that provide "contactless" delivery services to customers need to consider the reliability of delivery services, the security of the delivery environment, and the flexibility to respond to emergencies. In this way, the active adoption and continued use of technology-enabled "contactless" delivery services is promoted. In particular, it should be emphasized that under the inevitable trend of "coexisting with the COVID19 virus", in order to encourage more consumers to continue to accept technology-enabled "contactless" delivery services, logistics and distribution agencies must provide consumers with better privacy protection, delivery Reliability, flexibility to respond to emergencies, and secure delivery services from the threat of the COVID19 virus. To maximize the coordination and balance between the public health management of the future society and the daily economic life of consumers.

We would like to emphasize that the period in which the data was collected for this study is the period when people are returning to their daily lives after strict lockdowns. At this time, people's opinions and evaluations on the non-contact delivery service supported by technology have special practical significance. According to the viewpoints of survival psychology and consumer behavior, when individuals are threatened by the external environment, their short-term emergency behaviors will gradually become new habitual behaviors (e.g., consumer buying habits, choice of "last mile" delivery methods, etc.) due to the influence of some factors, and thus undergo sustainable essential changes (Yuen et al., 2020; Sheth, 2020; Mehta et al., 2020). This study collects sample data in this context and demonstrates the factors that influence consumers' intentions to continue using technology-enabled contactless delivery services. Then, the influencing factors identified and clarified in this study, supported by the theoretical viewpoints put forward in the past literature, have more practical reference value, and provide more practical reference literature for the sustainable development of the industry and logistics service enterprises.

Finally, this research can provide a realistic literature reference for governmental public health institutions. When the government's public health agencies formulate new versions of epidemic prevention rules and provide logistics and distribution companies with guidance and suggestions for epidemic prevention, this study can provide more practical references. At the same time, this study believes that influencing factors will promote the use of technology-supported contactless delivery services, which can assist logistics service companies to solve the "last mile" carbon emission problem they face and can help human society to achieve the goal of "zero carbon emission". Therefore, according to the views and suggestions expounded in this study, a new reference perspective can be provided for the realization of social responsibility of logistics service enterprises. This also provides an important reference for logistics service companies to introduce specific service forms and equipment resource allocation in the "last mile" delivery link. This research also brings more hope to the cooperation between logistics service enterprises and consumers, as well as the realization of a "green and zero carbon emission" human society. In addition, the content and conclusions of this study can provide valuable reference and empirical suggestions when the transportation authorities and industry associations provide policy guidance and suggestions on "energy saving and emission reduction" for logistics service enterprises.

## 5.2. Limitations and recommendations

Owing to the overly strict pandemic prevention measures in China, the social survey environment, and the integration of survey methods, this study has certain shortcomings. Firstly, in order not to violate relevant laws and regulations on epidemic prevention and control, and to strictly abide by COVID-19 preventive measures, this research can only survey Internet customers in an online form. Therefore, in future research, we aim to consider expanding the data on offline consumers and use this data for further empirical analysis, to provide more comprehensive literature for the research and development of contactless delivery services after the end of the COVID-19 pandemic.

Additionally, the survey collected a sample size that met the needs of a statistically significant study. However, there are limitations to this study with respect to the large number of consumers and diversity of cultural differences worldwide. And in the data samples obtained from the survey, the sampling ratios such as gender ratio and age ratio need to be further improved. Future studies should consider expanding the total number of samples collected, and adopting a reasonable allocation of sampling ratios to further increase the representativeness and diversity of the data samples.

Thirdly, this study considers behavioral experiments to obtain data on customer behavior for future studies. At the same time, a long-term survey is being considered to collect data on customers during the COVID-19 pandemic and after the pandemic has ended, as a way of

analyzing the results of studies comparing specific settings with the general period.

Finally, in order to continue the development of the research, in the future research, some research designs and assumptions will be supplemented, and some analytical elements and research methods will be supplemented. For example, more theoretical perspectives and influencing factors will be introduced in the future, so as to provide more discussions and reference suggestions for practical management issues. It will also focus on the analysis and discussion of the control variables (e.g., demographic variables) and moderating effects (e.g., gender, anxiety, and environmental orientation) on the relationship between various influencing factors, perceived value, and intention, so as to enhance the value of the research results and provide more diversified conclusions. Furthermore, we will refer to the past literature, add some covariates/control variables reasonably, and introduce the Lagrangian Multiplier (LM) test in the analysis to better enhance the academic significance and practical value of the research.

## Data availability

The authors are unable or have chosen not to specify which data has been used.

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