

Drone Food Delivery: A Solution to Crowding During the Global COVID-19 Pandemic

Gurmeet Singh , Shavneet Sharma , Anushree Tandon, and Puneet Kaur 

Abstract—The COVID-19 pandemic has altered the retail landscape and introduced new risks for customers. Customers, in turn, are increasingly turning toward technology to reduce pandemic-associated risks. This study investigates the impact of crowding at food retail outlets on customers' willingness to utilize drone food delivery. Data were collected using an online survey and analyzed using covariance-based structural equation modeling. The results confirm that crowding is positively associated with social withdrawal tendency and mortality threat. Perceived vulnerability and perceived severity act as moderators to strengthen the positive association of crowding with mortality threat and social withdrawal tendency. Social withdrawal tendency and mortality threat, in turn, are positively associated with customers' attitudes toward drone delivery. A positive attitude toward drone delivery positively impacts customer willingness to utilize drone delivery, while a negative attitude has a negative impact. This study provides novel insights into technology adoption driven by crowding as an environmental factor during a global pandemic. It also offers evidence that technology adoption is driven by threat perceptions. Our findings have important implications for retailers, who can consider drone food delivery as a possible solution to reduce customers' threat perception.

Index Terms—COVID-19, crowding, drone food delivery service, mortality threat, social withdrawal tendency.

I. INTRODUCTION

DRONES, also known as unmanned aerial vehicles (UAVs), were originally designed for military use [1] but have since found applications in multiple domains, including monitoring, traffic surveillance, and security and logistics [2]. Recently, online retail has joined these domains, with retailers such as Walmart, DHL, Google, and Amazon using drones for delivery purposes [3], [4]. With delivery services exhibiting significant growth in recent years [5]–[8], the popularity of drone delivery services has also increased, and drones have become a crucial part of the retail industry [9]. Drone delivery service is more

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feasible and environmentally friendly [10] than other delivery forms. Despite its many benefits, however, the full commercialization of drone delivery service has yet to occur due to customer risk perceptions rather than technical issues [2]. For example, scholars have identified security, privacy [9], psychological and performance risks [2] as pertinent customer-perceived issues in this regard. The public also exhibits anxiety and psychological resistance regarding drone delivery [11].

Nevertheless, retail-oriented applications for drones have gained particular prominence following substantial changes in the retailing environment and customer behavior, which resulted from the COVID-19 pandemic [12], [13]. In the current study, we highlight the specific concern of “crowding,” which scholars have previously recognized as a significant stressor for retail customers [14]–[16]. Due to the pandemic [17], customers are motivated to eliminate face-to-face retail interactions to decrease the risks associated with the COVID-19 virus [2]. With customers driven to seek contactless service [18], [19], drone delivery has emerged as a viable option for retailers who are exploring and implementing innovative solutions to counteract customers' pandemic-related concerns.

The hospitality management literature includes several studies on drone food delivery [20], with recent literature also exploring the influence of the global COVID-19 pandemic on such services. For instance, Hwang et al. [21] found that attitudes toward drone delivery are motivated by three subdimensions (social, hedonic, and functional), with the COVID-19 outbreak moderating the association of motivation on attitudes toward adoption [21]. Another study by Choe et al. [2] examined customers' risk perceptions of drone delivery before and after the COVID-19 pandemic, while focusing attention on the effect of five subdimensions of perceived risk (psychological, performance, privacy, time, and financial risk) on drone image and adoption. Hwang and Kim [22] investigated the influences of drone delivery benefits on customers' behavioral intentions during the COVID-19 pandemic. Their study found that emotion, function, convenience, social influence, and compatibility affect image, which, in turn, affects desire and behavioral influence intentions to use a drone during the pandemic.

Despite these studies' meaningful contributions, the literature exploring factors motivating customers to adopt drone delivery services remains scarce [4], [9], [23]–[26]. The gap is especially evident in investigations coupling store-related aspects with individual factors in the context of COVID-19. We bring attention to four fundamental knowledge limitations that motivate our study. First, while prior studies have examined customers' drone

delivery attitudes and adoption intentions, their efforts occurred before the pandemic [3], [23]. Given the ongoing impact of COVID-19 on retailing as well as estimations that some of these impacts may be long-term regardless of the pandemic, we believe that it is critical to account for the contextual effects of the pandemic. For instance, scholars have identified the threat of mortality as a significant influence on customers' behavior in tourism [27]. However, the threat of mortality remains unexplored in drone delivery during a pandemic. We thus assert the critical need for in-depth and expansive investigations to understand the factors motivating customer adoption of drone delivery amidst an unprecedented global pandemic [2], [22]. Indeed, these factors may remain significant even after the pandemic due to customers' latent health concerns. Second, prior studies have been limited in exploring the indirect effects of individual factors, such as customers' degree of perceived risks, on drone delivery adoption intentions [28]. The pandemic, however, has elicited varying customer responses influenced by individual factors, such as customers' perceived vulnerability as well as the severity of the threat they perceive from the COVID-19 virus [29]. For example, while some studies have reported that customers are wary of store crowding, others have shown customers to be more tolerant of crowding during the pandemic [27]. We argue that individual factors are critical because they can significantly influence behavior, especially when customers face a potential risk to self.

Third, the extant literature exhibits a significant lacuna in investigating the impact of factors related to the physical environment of brick-and-mortar food businesses on customer adoption of drone delivery. This is a critical knowledge gap in the current business environment wherein COVID-19 has led customers to feel "at risk" within crowded stores [15], [17] due to the potential for virus transmission and exposure. For instance, Hou et al. [14] found that store crowding leads tourists to develop social withdrawal tendencies, which ultimately motivate their reliance on service robots over human staff. Finally, prior studies have not considered the valence of attitudes toward drone delivery [3], [4], [28]. In fact, researchers have cautioned against conceptualizing attitude as a single dimension [30], and previous studies have highlighted the bivalent nature of attitude comprising negative and positive emotions. Thus, investigations into the valence of attitude (positive and negative attitudes toward drone delivery) are also necessary. To address these limitations and understand the nuances of customers' motivation for drone delivery adoption, we adopt a theoretical lens to answer the following research questions (RQs):

- RQ1.* Does crowding influence customers' social withdrawal tendency and mortality threat?
- RQ2.* Do social withdrawal tendency and mortality threat influence attitudes toward drone delivery?
- RQ3.* Does the valence of attitudes influence customers' willingness to adopt drone delivery service?
- RQ4.* Do perceived vulnerability and severity moderate the relationship between crowding and mortality threat?

We employed covariance-based structural equation modeling (CB-SEM) analysis to answer these RQs and test the

hypothesized associations using data collected from 439 respondents. Our study offers the following contributions. First, we provide more nuanced insights into changing customer motivations and behavior as a result of the COVID-19 pandemic, thereby answering the call for deeper investigations into such changes [29], [31], [32] in the retailing environment. Furthermore, we add to existing knowledge on drone delivery service adoption by accounting for the pandemic's disruptive environmental effects, which is an essential topic of interest [29], [31], [32]. Second, this study explores a novel pathway for investigating the possibly joint motivation of drone delivery services by individual and physical store-related factors. This represents a valuable contribution because prior studies on drone delivery have urged scholars to explore other independent variables affecting adoption [3], [33]. Third, this study adopts a dual theoretical lens to address the above RQs. To the best of our knowledge, threat appraisal and risk calculus theories remain underexplored in our context, and we contribute to the existing literature by examining their efficacy in a previously untested setting. In doing so, we increase the generalizability of these theories [34]–[36]. Fourth, prior studies on drone delivery have focused primarily on developed countries, such as Korea [2], [22], [37] and Turkey [38], while devoting less attention to developing nations, such as India [39]. By providing new empirical insights into drone delivery adoption in Fiji, our work contributes to expanding such knowledge in developing nations.

The rest of the article is organized as follows. The literature review, hypotheses, and research model are outlined in Section II, while Section III presents the methodology. We detail our results in Section IV and subsequently discuss them in Section V. Finally, Section VI highlights the study's limitations, implications, and concluding remarks.

II. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

A. Theoretical Background

Risk calculus theory asserts that people consider costs and benefits before they engage in a particular behavior [40], and this theory has been utilized extensively to examine privacy concerns [41]. An individual's risk calculus involves balancing the expected risk of engaging in an action with the individual's ability to cope [41]. To our knowledge, few studies have applied this theory in the context of COVID-19. However, scholars have previously introduced perceived vulnerability and severity in theoretical models to investigate individuals' risk perceptions [29] in other situations.

Threat appraisal theory is likewise relevant to the current study. Threat appraisal theory highlights the psychological process in which an individual engages following exposure to an external stimulus [42]. It states that an individual faced with a stressor appraises the potential dangers, benefits, and relevance [43]. In this study, the stressor refers to the health threat individuals perceive as a result of COVID-19 [31]. We posit perceived vulnerability and severity as indirect stressors in the decision to adopt drone delivery and thereby cope with the risks of COVID-19. Fig. 1 illustrates this study's research model on the basis of the formulated hypotheses discussed in subsequent

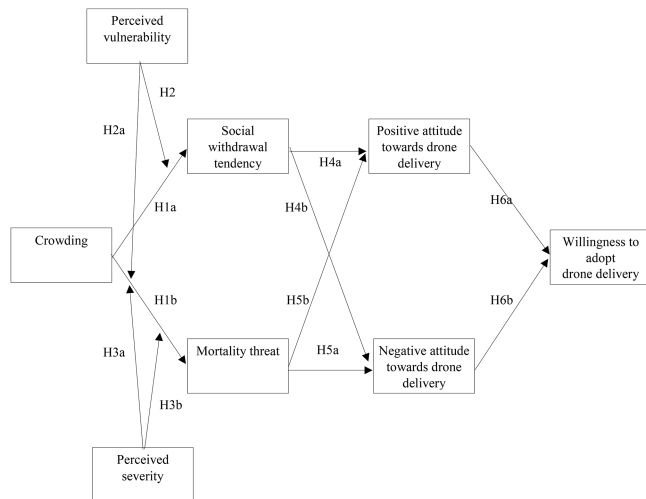


Fig. 1. Conceptual framework.

sections through the dual theoretical lens of threat appraisal theory and risk calculus theory.

B. Hypotheses Development

Stokols proposed the seminal work on crowding Stokols [44]. Perceived crowding refers to individuals' psychological perceptions regarding their closeness to others in a limited space [15]. However, the concept of crowding is subjective [15]. For instance, a person who is accustomed to living in large spaces may feel more crowded than an individual who is used to living in smaller spaces.

The extant research shows that crowded retail environments impact customers. Eroglu *et al.* [47] found that in-store crowding affects customer satisfaction. Another study by Machleit *et al.* [48] revealed that customers' tolerance for crowding varies across retail stores and that crowding influences customers' purchasing behavior. Mehta [49] stated that stores' atmospheres are affected by crowding, and customers' perceptions of crowding vary based on different direct and indirect (mediating) variables. Environmental psychology theory states that psychological consequences—for example, increased motivation toward safety [50] and increased motivation toward personal control—occur because of crowding [51].

Evidence suggests that exposure to respiratory droplets containing the COVID-19 virus is the principal mode of transmission [52]. With this knowledge, customers' attitudes toward crowding during this pandemic have changed dramatically. Gupta and Coskun [17] found that customers perceive a high potential for contamination in crowded retail stores amidst the COVID-19 pandemic. Chang [15] found that crowding in retail stores during the COVID-19 crisis increases employee risk perceptions. Similarly, Hou *et al.* [14] confirmed that tourists experience enhanced social withdrawal tendencies due to crowding. However, Pantano *et al.* [53] stated that customers are more tolerant toward crowding amidst the COVID-19 outbreak. Still, customers tend to prefer shops with better social distancing and are willing to wait in long lines to gain store access [54].

Additionally, customers who receive advance information relating to crowding exhibit increased social withdrawal tendencies; however, this has been found to enhance customers' experience [55]. Similarly, travelers show a decreased preference toward crowded hospitality and travel options [56]. These inconsistent results highlight the need for further investigation. Additionally, Nanni and Ulqinaku [27] recently found that mortality threat increases customer technology adoption in terms of virtual tours. Based on this discussion, it is likely that customer-perceived crowding in retail stores during the COVID-19 pandemic increases their social withdrawal tendency and perceived mortality threat. Therefore, we propose the following hypotheses:

H1a: Crowding is positively associated with social withdrawal tendency.

H1b: Crowding is positively associated with mortality threat.

According to Seiders and Berry [57], a high degree of perceived vulnerability leads customers to perceive trust issues with their service providers. The COVID-19 crisis has increased customers' concerns about dine-in restaurants by increasing their perceived vulnerability [58]. A study conducted in ten countries in Asia, the Americas, and Europe found that individuals perceive a high level of vulnerability to contracting COVID-19 [59]. Park *et al.* [60] demonstrated that individuals' perceived vulnerability to COVID-19 causes them to engage in self-protective behavior. Studies have confirmed that increased perceptions of one's vulnerability to COVID-19 lead to anxiety and fear [60], [61]. The extant literature has also revealed that a high degree of vulnerability to infection leads individuals to reduce their affiliation with others and practice interpersonal avoidance [62]–[64]. Boyraz *et al.* [65] found that perceived vulnerability is positively associated with an individual's social isolation and stress. Based on this discussion, we expect that customers with a high degree of perceived vulnerability to COVID-19 will exhibit a stronger association of crowding with social withdrawal tendency and mortality threat. As such, we propose the following hypotheses:

H2a: Perceived vulnerability strengthens the positive association between crowding and social withdrawal tendency.

H2b: Perceived vulnerability strengthens the positive association between crowding and mortality threat.

A person's perception of the perceived threat severity—in this case, of the virus—leads them to adopt preventive measures to control the threat [66], [67]. Prior studies have demonstrated that the perceived severity of life-threatening diseases, such as pandemics [68], [69] and other health issues [70], causes individuals to take protective measures. Webb and Sheeran [71] stated that individuals must have a compelling reason to alter their behavior. The perceived severity of COVID-19 can provide such a justification. Laato *et al.* [72] confirmed that perceived severity is positively associated with self-isolation intentions. Farooq *et al.* [73] also found that the perceived severity of the COVID-19 threat leads to self-isolation intentions. We thus expected that customers who perceive the threat severity of COVID-19 to be high will exhibit a stronger relationship of

crowding with social withdrawal tendency and mortality threat. Therefore, we propose the following hypotheses:

H3a: Perceived severity of the COVID-19 threat strengthens the positive association between crowding and social withdrawal tendency.

H3b: Perceived severity of the COVID-19 threat tendency strengthens the positive association between crowding and mortality threat.

Studies have shown that individuals perceive crowding to be an intrusion on their personal space [74]. As a response to the threats imposed by crowding, individuals attempt to implement various coping strategies [74], [75], such as reducing unwanted and unnecessary interactions [75], [76]. Evans and Wener [76] observed passengers on a crowded train engaging in physical distancing from others. Scholars have, however, conducted limited studies on the association between social withdrawal tendency and adoption intentions toward technology. Andrews et al. [77] found that individuals paid greater attention to technology, particularly mobile phones, in an effort to avoid social interactions. This highlights the effectiveness of technology in assisting people who seek to avoid physical social interactions. Caplan [78] found that individuals with high social withdrawal tendency prefer to interact virtually—for example, through robot servers—rather than face-to-face [14]. Thus, we anticipate that individuals with a high social withdrawal tendency will be more likely to adopt drone food delivery services to avoid crowding amidst the COVID-19 pandemic. Therefore, we offer the following hypotheses:

H4a: Social withdrawal tendency is positively associated with a positive attitude toward drone delivery.

H4b: Social withdrawal tendency is negatively associated with a negative attitude toward drone delivery.

Humans fear mortality above any other threat [79]. The large number of deaths arising from the COVID-19 pandemic has increased people's fear of death [80]. According to terror management theory, the threat of mortality affects individuals' behavior [81]. In the tourism context, for example, the threat of mortality leaves individuals reluctant to travel [82]. Individuals, in turn, have a positive attitude toward products that decrease their mortality threat [83]. Ritchie and Jiang [84] found that providing individuals with access to solutions during threatening, challenging, and uncertain times is critical. Nanni and Ulqinaku [27] highlighted the importance of technology adoption to overcoming mortality threats among individuals engaging in virtual tours. Based on the above discussion, we expect that customers who face a mortality threat during the COVID-19 crisis will be willing to utilize drone food delivery as a coping strategy. Therefore, we develop the following hypotheses:

H5a: Mortality threat is positively associated with a positive attitude toward drone delivery.

H5b: Mortality threat is negatively associated with a negative attitude towards drone delivery.

In this study, customers' attitudes refer to their positive and negative evaluations of drone delivery services. The literature

has shown that attitude impacts an individual's behavior [85]–[87]. For instance, Dhir et al. [88] confirmed that customers' attitudes impact their behavioral intentions toward apparel products. Sreen et al. [89] found a similar relationship between attitude and behavior in the case of natural product adoption. Hwang et al. [21] confirmed that attitude toward drone delivery positively influenced customers' use intentions. In addition, Yaprak et al. [38] confirmed attitude as an antecedent of drone delivery adoption. However, attitude encompasses both positive and negative aspects toward the same phenomenon. For example, Boley et al. [46] found that certain factors related to tourism (e.g., psychological empowerment) significantly affect customers' positive and negative attitudes toward tourism. Thus, this study investigates the impact of attitude valence (positive and negative attitudes) toward drone delivery on willingness to adopt the technology as a response to COVID-19-related threats. Based on the above discussion, we propose the following hypotheses:

H6a: Positive attitude toward drone delivery is positively associated with customers' willingness to adopt drone delivery.

H6b: Negative attitude toward drone delivery is negatively associated with customers' willingness to adopt drone delivery.

C. Socio-Demographics as Control Variables

Recognizing the potential confounding effects on our study's dependent variable (i.e., willingness to adopt drone delivery), we utilized education, income, age, and gender as control variables. The choice of these control variables is justified by their use in prior studies on consumer behavior [90].

III. METHOD

A. Measurement

We employed a seven-point scale to measure the variables. The items—including crowding and social withdrawal tendency [14], mortality threat [27], perceived severity, perceived vulnerability, drone delivery adoption intention [29], and positive attitude and negative attitude toward drone delivery [91], [92]—were adapted from pre-validated scales utilized in previous studies on information systems and customer behavior. Table I provides operational definitions of these study variables. We asked three experts in marketing, information systems, and hospitality management to assess the survey instrument and ensure the suitability of our adaptations to the items. The experts suggested minor changes to improve language and phrasing, which we implemented. This step ensured that the survey items were relevant to our study context, and the experts confirmed face validity.

B. Sampling and Data Collection

We employed a cross-section survey design to test the hypotheses proposed in Fig. 1. The population of this study consisted of food customers in Fiji, a South Pacific country comprised of approximately 300 islands. Because the study sought to examine willingness to adopt drone delivery rather than actual usage behavior, customers, in general, were a suitable

TABLE I
OPERATIONAL DEFINITIONS OF STUDY VARIABLES

Measures	Description	Source
Crowding	Customers' perception of the density of people in a fixed space	[14]
Social withdrawal tendency	The degree to which individuals avoid interacting with others	[14]
Mortality threat	The fear of dying after contracting COVID-19	
Perceived vulnerability	Customers' evaluation of their risk of contracting COVID-19	[45]
Perceived severity	The negative consequences customers attribute to COVID-19	[29]
Positive attitude towards drone delivery	Customers' positive feelings about drone delivery service	[46]
Negative attitude towards drone delivery	Customers' negative feelings about drone delivery service	[46]
Willingness to adopt drone delivery	The strength of a customer's intention to use drone delivery service	[29]

population [9]. Prior to conducting the main survey, we ensured the survey instrument's content validity by organizing a pilot study involving 25 post-graduate students at Fiji University. The pilot study participants, who were similar to the population of the main survey, evaluated the questions in the survey instrument for clarity and understandability. Based on the pilot study results, we made minor language and wording changes to the items. Subsequently, we utilized SurveyMonkey to create an online survey. SurveyMonkey is a reliable platform to host online surveys, and it enabled us to continue data collection despite restrictions on movement implemented in the country during the process. The survey link and an invitation to participate were circulated to potential respondents for four weeks in May 2021 via a sponsored advertisement on Facebook, which is the most commonly used social networking site in Fiji [93]. The survey was voluntary, and respondents did not receive any incentives for participating. Prior studies have employed this method of data collection [34], [86], [92].

We collected a total of 462 responses and eliminated 23 responses because they contained incomplete data or were outliers (based on *Z*-scores). The kurtosis, skewness, and normality of the data were confirmed based on Hair *et al.* [94] guidelines. We established the nonexistence of multicollinearity issues using the variance inflation factor and tolerance values. Table II details the demographic profile of the 439 remaining respondents. We employed CB-SEM to analyze the data. The use of this method is justified to test hypotheses after data suitability is confirmed [95].

IV. RESULTS

A. Reliability, Validity, and Measurement Model

Confirmatory factor analysis (CFA) indicated that the factor loadings exceeded 0.50. The CFA also confirmed a good fit for the measurement model ($\chi^2/df = 1.98$; $CFI = 0.96$; $GFI = 0.93$; $TLI = 0.94$; $NFI = 0.93$; $RMSEA = 0.037$; P -close = 0.260). Composite reliability was verified because all construct items' reliabilities exceeded the threshold of 0.70, and convergent validity was verified because the average variance extracted

TABLE II
PARTICIPANTS' DEMOGRAPHIC PROFILE

Demographic variables	N	%
Gender		
Male	231	52.62
Female	206	46.92
Do not wish to indicate	2	0.46
Age		
Below 18	96	21.88
18–25 years	152	34.62
26–30 years	101	23.01
31–40 years	78	17.78
41–50 years	12	2.73
50 years and above	-	-
Qualification		
Primary	-	-
Secondary	44	10.02
Tertiary	395	89.98
Income		
Under \$5,000	81	45.11
\$5,000–\$10,000	207	27.07
\$10,001–\$20,000	96	25.56
\$20,001+	55	2.26

TABLE III
STUDY VARIABLE MEASUREMENTS

Variables and items	Model and item indices					
	SL	SMC	Mean	SD	CR	AVE
CWD			5.65	1.53	0.88	0.70
CWD1	0.82	0.67	5.81	1.68		
CWD2	0.84	0.71	5.46	1.47		
CWD3	0.85	0.72	5.69	1.45		
SWT			6.20	1.61	0.86	0.67
SWT1	0.82	0.67	6.16	1.54		
SWT2	0.79	0.62	5.96	1.88		
SWT3	0.85	0.72	6.47	1.42		
MRT			6.33	1.59		
MRT1	0.92	0.85	6.79	1.29	0.92	0.80
MRT2	0.89	0.79	6.76	1.63		
MRT3	0.87	0.76	5.43	1.85		
PVN			6.35	1.47	0.84	0.63
PVN1	0.76	0.58	6.71	1.18		
PVN2	0.78	0.61	5.97	1.24		
PVN3	0.84	0.71	6.36	1.99		
PSV			5.96	1.53	0.92	0.80
PSV1	0.92	0.85	5.66	1.55		
PSV2	0.87	0.76	5.45	1.13		
PSV3	0.89	0.79	6.78	1.91		
NAD			6.41	1.31	0.87	0.69
NAD1	0.84	0.71	6.79	1.14		
NAD2	0.81	0.66	6.27	1.52		
NAD3	0.84	0.71	6.16	1.28		
PAD			6.07	1.44		
PAD1	0.83	0.69	6.64	1.14	0.94	0.76
PAD2	0.86	0.74	5.31	1.68		
PAD3	0.92	0.85	5.89	1.74		
PAD4	0.88	0.77	5.69	1.27		
PAD5	0.87	0.76	6.81	1.36		
WAD			5.99	1.58		
WAD1	0.81	0.66	5.98	1.88	0.92	0.73
WAD2	0.88	0.77	6.67	1.74		
WAD3	0.85	0.72	5.19	1.15		
WAD4	0.88	0.77	6.12	1.56		

Note: AVE = Average variance extracted; SL = Standardised loadings; SME = Squared multiple correlations; SD = Standard deviation; CR = Composite reliability.

TABLE IV
DISCRIMINANT VALIDITY

	CR	AVE	MSV	MaxR(H)	CWD	SWT	MRT	PVN	PSV	NAD	PAD	WAD
CWD	0.88	0.7	0.41	0.89	0.74							
SWT	0.86	0.67	0.52	0.84	0.43	0.73						
MRT	0.92	0.8	0.48	0.86	0.12	0.34	0.83					
PVN	0.84	0.63	0.55	0.81	0.34	0.18	0.15	0.77				
PSV	0.94	0.77	0.52	0.84	0.36	0.27	0.13	0.44	0.87			
NAD	0.87	0.69	0.57	0.83	0.43	0.15	0.16	0.18	0.26	0.79		
PAD	0.94	0.76	0.55	0.88	0.13	0.46	0.24	0.41	0.18	0.36	0.87	
WAD	0.92	0.73	0.44	0.86	0.19	0.28	0.25	0.28	0.28	0.43	0.39	0.82

Note. The boldfaced figures are the square root of the variance shared between the variables and their measures. Correlations between variables are the off-diagonal elements. CWD = Crowding; SWT = Social withdrawal tendency; MRT = Mortality threat; PVN = Perceived vulnerability; PSV = Perceived severity; NAD = Negative attitude; PAD = Positive attitude; WAD = Willingness to adopt; CR = Composite reliability; MSV = Maximum shared variance; MaxR(H) = Maximum reliability; AVE = Average variance extracted.

TABLE V
HTMT ANALYSIS

	CWD	SWT	MRT	PVN	PSV	NAD	PAD	WAD
CWD								
SWT	0.25							
MRT	0.71	0.63						
PVN	0.35	0.71	0.44					
PSV	0.76	0.14	0.75	0.21				
NAD	0.38	0.18	0.54	0.68	0.74			
PAD	0.53	0.41	0.62	0.61	0.37	0.79		
WAD	0.22	0.48	0.76	0.34	0.66	0.75	0.71	

Note. CWD = Crowding; SWT = Social withdrawal tendency; MRT = Mortality threat; PVN = Perceived vulnerability; PSV = Perceived severity; NAD = Negative attitude; PAD = Positive attitude; WAD = Willingness to adopt.

(AVE) values exceeded 0.50 (see Table III). Discriminant validity was confirmed by AVE values that exceeded their correlation coefficients with other constructs (see Table IV). Additionally, the heterotrait-monotrait (HTMT) figures for each construct pair were below 0.9 (see Table V).

B. Common Method Bias

Due to our utilization of a single source to collect the data and the study's cross-sectional design, the study was vulnerable to common method bias (CMB). Using Herman's single-factor tests, however, we confirmed the absence of this issue, with a single factor explaining only 31.06% of the variance, which is well below the threshold of 50%. Consistent with the approach of Bhutto et al. [96], we also employed *blue attitude* as a construct theoretically unrelated to the study's constructs; because *blue attitude* was uncorrelated with the other variables, we thus further confirmed the absence of CMB.

C. Control Variables

The control variables for this study did not influence the dependent variables. Income, education, gender, and age had no confounding effect on the willingness to adopt drone delivery.

D. Structural Model

The study's structural model exhibited a good model fit ($\chi^2/df = 1.98$; $CFI = 0.96$; $GFI = 0.93$; $TLI = 0.94$; $NFI = 0.92$; $RMSEA = 0.049$; $p\text{-close} = 0.135$). First, we tested the proposed

TABLE VI
MODERATION RESULT

Perceived vulnerability	B	T	p	LLCI	ULCI	Moderation?
CWD → SWT	0.28	2.62	0.01	0.0201	0.1436	Yes
CWD → MRT	0.03	3.81	0.00	0.0163	0.0506	Yes
Perceived severity						
CWD → SWT	0.16	4.17	0.00	0.0118	0.0362	Yes
CWD → MRT	0.02	3.02	0.05	0.0003	0.3124	Yes

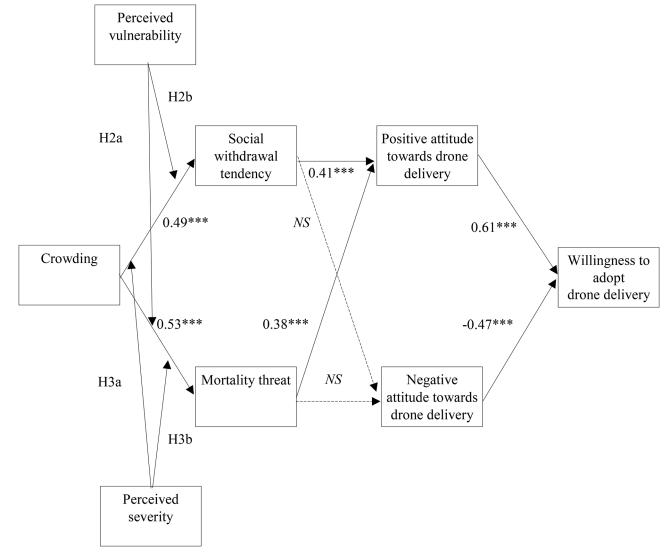


Fig. 2. Analysis results.

direct relationships. We found crowding to be positively related to both social withdrawal tendency ($\beta = 0.49$, $p < 0.001$) and mortality threat ($\beta = 0.53$, $p < 0.001$). Social withdrawal tendency ($\beta = 0.41$, $p < 0.001$) and mortality threat ($\beta = 0.38$, $p < 0.001$), in turn, were positively related to positive attitude toward drone delivery. Finally, positive attitude toward drone delivery was positively related to willingness to adopt drone delivery ($\beta = 0.61$, $p < 0.001$), while negative attitude toward drone delivery was negatively related to willingness to adopt drone delivery ($\beta = -0.47$, $p < 0.001$). On the basis of these analyses, we thus accepted H1a, H1b, H4a, H5a, H6a, and H6b (see Fig. 2).

E. Moderation Analysis

Table VI presents the moderation results computed using PROCESS macro in SPSS. We examined perceived vulnerability and perceived severity as moderators. The results revealed that perceived vulnerability strengthened the positive associations between crowding and social withdrawal tendency (H2a; see Fig. 3) and between crowding and mortality threat (H2b; see Fig. 4). In addition, perceived severity strengthened the positive associations between crowding and social withdrawal tendency (H3a; see Fig. 5) and between crowding and mortality threat (H3b; see Fig. 6).

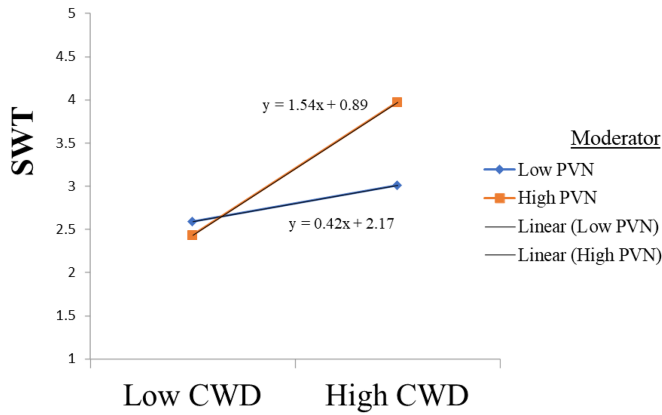


Fig. 3. PVN strengthens the positive association between CWD and SWT.

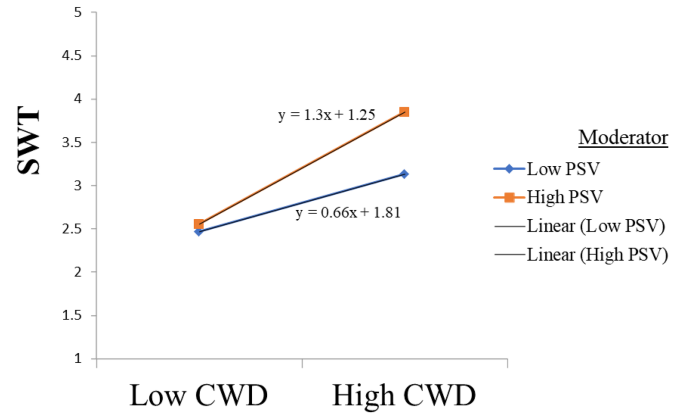


Fig. 5. PSV strengthens the positive association between CWD and SWT.

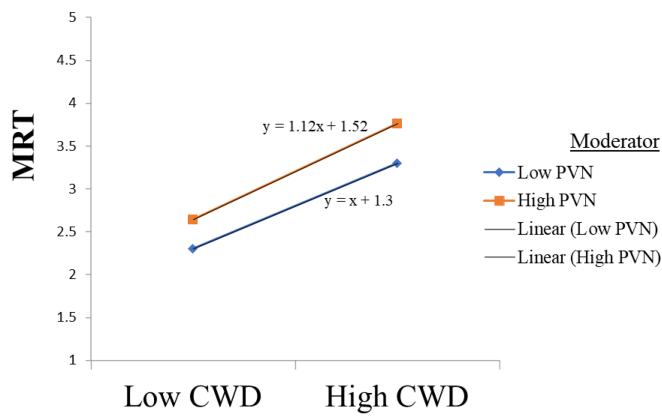


Fig. 4. PVN strengthens the positive association between CWD and MRT.

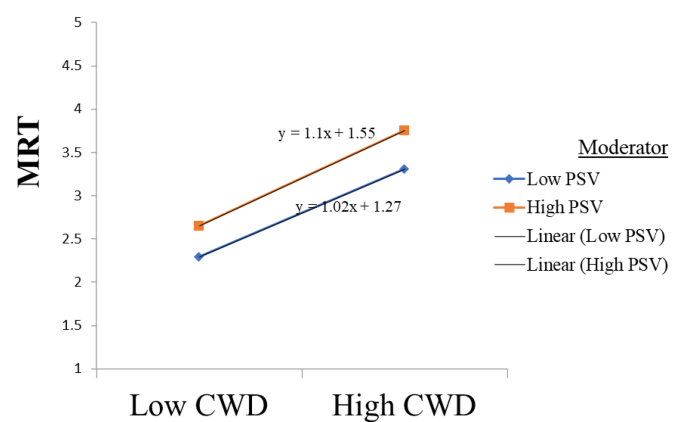


Fig. 6. PVN strengthens the positive association between CWD and MRT.

V. DISCUSSION

We formulated the conceptual model to investigate the impact of crowding at food retail outlets on customers' willingness to adopt drone food delivery. The data analyzed via CB-SEM confirmed six hypotheses (H1a, H1b, H4a, H5a, H6a and H6b), lending partial support to our proposed research framework.

First, the findings confirmed the positive association between crowding and social withdrawal tendency (*H1a*). This result implies that customers who perceive retail stores to be crowded are likely to avoid interacting with other customers in the shop due to the threat of COVID-19. Although scholars have not previously tested this exact relationship, they have found similar results in other settings. For instance, crowding was previously found to influence psychological consequences, such as an enhanced individual drive for safety [50] and personal control [51]. Our study also confirmed *H1b*, which examined the positive association between crowding and mortality threat. This result implies that crowding in retail stores during the COVID-19 pandemic increases customers' perceived mortality threat—likely because crowds increase the risk of contracting COVID-19 [97], and wearing masks does not provide complete protection against a respiratory virus that is transmitted via an infected person's coughing and sneezing [98]. Prior studies on the impact of crowding during the pandemic have confirmed similar results for employees' Chang [15] and customers' perceived contamination risk Gupta and Coskun [17]. Additionally,

our results revealed that retail store crowding has a more significant effect on customers' mortality threat than on their social withdrawal tendency. This highlights the fear the pandemic causes for customers who consider crowds to be life-threatening situations.

H2a was also confirmed, with perceived vulnerability strengthening the positive association between crowding and social withdrawal tendency. This result implies that customers' who perceive a high degree of vulnerability from the COVID-19 virus are more likely to exhibit social withdrawal tendencies when they experience crowding in retail stores. Customers with pre-existing medical conditions, such as diabetes or heart or lung disease, and those who are immunocompromised are particularly likely to feel vulnerable to the COVID-19 virus [52]. Prior studies have produced similar results. Min *et al.* [58] found that the COVID-19 crisis has increased customers' concerns about dine-in restaurants by increasing their perceived vulnerability. In addition, Park *et al.* [60] showed that perceived vulnerability to COVID-19 causes individuals to engage in self-protective behavior. Our study also confirmed *H2b*, which examined the role of perceived vulnerability in strengthening the positive association between crowding and mortality threat. This result implies that customers who consider themselves highly vulnerable to the COVID-19 pandemic are more likely to perceive higher mortality threats in crowded retail stores. We attribute this result to the fact that customers with pre-existing

conditions likely perceive themselves to be highly vulnerable to severe symptoms and a greater mortality threat as a result of the COVID-19 virus. Although, to the best of our knowledge, scholars have not previously tested the same hypothesis, they have reported similar results in other contexts. For instance, studies have confirmed that individuals' increased perception of their vulnerability to COVID-19 leads to anxiety and fear [60], [61] regarding the virus' consequences.

The findings from our study also confirmed that perceived severity strengthens the positive association between crowding and social withdrawal tendency (*H3a*). This means that customers who perceive the severity of the threat from COVID-19 to be high are more likely to exhibit social withdrawal tendencies when retail stores are crowded. Because the symptoms of COVID-19 can vary considerably [99], [100], customers who perceive a high threat severity and consider themselves at high risk of contracting the virus are more likely to isolate themselves from other retail customers who may already be infected. Prior studies in other contexts have produced similar results. For example, studies have shown that individuals' perceptions of the perceived severity of the virus lead them to adopt preventive measures to gain control of the threat [66], [67].

In addition, the results from this study confirmed *H3b*, which proposed that perceived severity strengthens the positive association between crowding and mortality threat. This finding implies that customers who perceive the severity of the threat from COVID-19 to be high are more likely to perceive a higher mortality threat in crowded retail stores. This result may be a result of the increased likelihood of contracting the COVID-19 virus in crowded areas [100]. Studies conducted previously have found similar results. For instance, Farooq et al. [73] confirmed that the perceived severity of the COVID-19 threat encourages self-isolation intentions. Studies have also demonstrated that the perceived severity of life-threatening diseases, such as pandemics [68] and other health issues [70], leads individuals to adopt protective measures.

Next, we confirmed support for *H4a*, which examined the proposed positive association between social withdrawal tendencies and a positive attitude towards drone delivery. This result implies that customers who exhibit social withdrawal tendencies are more likely to develop a positive attitude toward drone delivery. We attribute this finding to the contactless delivery option that drones offer, which circumvents the need for person-to-person interactions and thus reduces the perceived risk of contracting COVID-19 [2]. While prior studies have not tested this exact relationship, the existing literature has shown that individuals utilize various coping strategies in response to the threats imposed by crowding [74], [75]. For instance, Evans and Wener [76] observed passengers on a crowded train physically distancing themselves from others due to safety and health concerns associated with crowding. Surprisingly, though, our results did not confirm *H4b*, which proposed a negative association between social withdrawal tendencies and a negative attitude toward drone delivery. This finding is inconsistent with prior results, which have demonstrated customers' preference for virtual and technological solutions that enable them to withdraw from social and human contact during the pandemic [14]. One

explanation for our surprising findings may be that customers who exhibit social withdrawal tendencies also seek solutions to crowding in retail stores. Because drone delivery offers such a solution, customers' negative attitude toward drone delivery remains unaffected.

Our results also confirmed a positive association between mortality threat and a positive attitude toward drone delivery (*H5a*). This result implies that customers who perceive a high mortality threat from the COVID-19 crisis exhibit a more positive attitude toward drone delivery as a solution to crowding in retail stores. While we did not find empirical support for this exact relationship in the literature, we did locate support in other contexts. For instance, studies have shown that individuals exhibit a positive attitude toward products that reduce their mortality threat [83]. In addition, Nanni and Ulqinaku [27] highlighted the importance of technology adoption to overcome mortality threats among those engaging in virtual tours. Meanwhile, our findings did not support *H5b*, which proposed a negative association between mortality threat and a negative attitude towards drone delivery (*H5b*). This result could be because customers who seek technological solutions to crowding threats during the COVID-19 crisis are likely to have a positive attitude toward such technologies. Ritchie and Jiang [84] asserted the importance of solutions during threatening, challenging and uncertain times. Because, as a form of contactless delivery, drones offer a way to reduce the risk of infection, customers' negative attitude toward drone delivery remain unaffected.

Finally, this study confirmed both *H6a*, which proposed a positive association between customers' positive attitude toward drone delivery and their willingness to adopt drone delivery, and *H6b*, which proposed a negative association between customers' negative attitude toward drone delivery and their willingness to adopt drone delivery. These results imply that customers' attitude toward drone delivery—and their attitude valence in particular—plays a critical role in their willingness to adopt such services. Our results align with those of prior studies, which present similar findings in other contexts [21], [38]. These results indicate that customers' positive or negative attitudes toward drone delivery depend upon their comprehensive and subjective evaluation of the costs and benefits of such an action.

VI. CONCLUSION

The COVID-19 pandemic has dramatically influenced customers' willingness to adopt emergent retail technologies. This study examined factors affecting customers' drone delivery adoption in Fiji during the global pandemic. Based on 439 completed responses collected via the online survey and analyzed via CB-SEM, we confirmed that crowding is an issue of concern for customers due to the threat of COVID-19, which suggests that drone delivery is a viable solution for customers during this crisis. Our results contribute to the scarce literature on drone delivery and customer behavior during an unprecedented global pandemic, and they provide practitioners, such as service providers, managers, policymakers, and retailers, with meaningful insights into customers' perceptions and drone delivery adoption intentions during a global pandemic.

A. Theoretical Implications

This study contributes to the literature on technology adoption and customer behavior in the context of an unprecedented global pandemic. Because disasters lead individuals to alter their behavior, scholars in these fields have advocated for additional research during these times [29], [31], [32]. The current study responds to this call and addresses multiple lacunae in the extant literature. First, while studies have previously examined drone delivery adoption, most such efforts occurred before the pandemic [3], [4], [9]; therefore, they could not account for the changes induced by this situational context. The current study addresses this gap. Second, previous scholars have devoted less attention to the relationship between environment factors of brick-and-mortar retailers and drone delivery adoption. The results of our study confirm that store crowding during the COVID-19 pandemic increases customers' social withdrawal tendency and mortality threat, thereby highlighting the need for innovative customer service solutions.

The current study also explored a novel pathway by which store-related factors, such as crowding in the context of COVID-19, and individual factors facilitate technology adoption. While prior studies have highlighted the adverse effects of store crowding on customers [101], [102], we propose it as an essential antecedent to drone delivery adoption. Based on our results, we emphasize the need to study other physical environment factors, such as adherence to social distancing rules and store sanitization efforts, as other possible antecedents to the adoption of drone delivery.

Third, this study contributes to threat appraisal theory by confirming that perceived vulnerability and mortality increase customers' threat perception. Both factors, moreover, strengthen the positive association between crowding and social withdrawal tendency. Our study thus contributes to existing knowledge by confirming the viability of this theory's application in a new, previously untested context and thereby increasing its generalizability [35], [36], [103]. In this way, our study makes valuable theory contributions and underscores the need for scholars to invoke other psychological and organizational behavior theories to study COVID-19-related disruptions in the retail sector.

Fourth, we offer additional insights into perceptions of drone delivery among customers in developing countries. In particular, our study makes a significant contribution to the state of the art by providing the first empirical results from Fiji. In fact, previous studies have confirmed that factors such as culture, economic environment, and technology infrastructure, among others, can contribute to variations in customer behavior [85], [92], [104]. Thus, we emphasize the need for further studies to understand customer behavior in economies such as Fiji, which are more self-reliant due to geographical or economic constraints.

B. Practical Implications

This study's findings offer practical implications for service providers, managers, policymakers, and retailers. First, the findings reveal that crowding in stores enhances customers'

perceptions of vulnerability and threat severity and thus promotes their social withdrawal tendencies and mortality threats. These results have significant implications for food retailers who provide essential goods and, therefore, have much to gain from addressing customers' concerns regarding store crowding. One possible solution to this issue is virtual queueing, which does not require customers to wait in lines in the store or even physically interact with a kiosk to obtain a ticket. With QR codes strategically placed at store entrances, customers can use their mobile phones to enter virtual queues and then receive a notification on their phones when it is their turn to be served. This allows customers greater control over their circumstances and the ability to avoid crowding near checkout counters. Scheduled pickup (also known as click and collect or kerbside pickup), which allows customers to choose a timeslot to collect their purchases, offers another solution to store crowding. Both of these options, however, require customers to leave the safety of their homes. Drone delivery, in contrast, eliminates contact and enables customers to receive products while remaining at home. We urge retailers to consider these and other possible solutions to decrease the threats that have arisen—primarily due to COVID-19.

Second, the findings from this study highlight the influence of social withdrawal tendencies and mortality threat on customers' positive attitude toward drone delivery. While traditional delivery forms require person-to-person contact and thus increase the risk of infection for both delivery workers and customers [2], drone delivery offers a contactless delivery solution that not only reduces transportation time but also mitigates the risks for employees and customers. Promoting drones as a risk-free delivery solution has the potential to further enhance customers' attitudes toward the service. We recommend that retailers utilize advertisements to highlight the potential safety, environmental and efficiency benefits of drone delivery [10] compared to traditional delivery methods, such as motorbikes or cars. Testimonial advertisements from local customers who are already using the service can further encourage trust and adoption among potential customers. For example, businesses can use their social media sites to post videos of current customers' reactions to receiving their products via drones and thereby create more positive attitudes toward drone delivery. In addition, food retailers can offer customers monetary or promotional discounts to opt for drone delivery. By leveraging this innovative delivery form, retailers can gain a competitive edge over their competitors.

Third, given customers' positive attitudes and intentions to adopt drone delivery as a way to combat COVID-19-related threats, policymakers should consider fully commercializing drone delivery. To this end, experts and practitioners in the industry can document and collect relevant data that would assist policymakers in developing regulations related to drone delivery in other contexts, such as medical supplies and food rationing. Policymakers can also promote more positive attitudes toward contactless drone delivery and encourage its adoption by communicating the benefits of the service across various media channels. These efforts will serve to better prepare the public and

thus reduce any delays or hesitations to drone delivery adoption during future crises.

C. Limitations and Future Scope

Despite this study's contributions, we must also acknowledge its limitations. First, the study collected data from Fiji, a small island and developing state with a unique culture. Therefore, the generalizability of its findings to customers from other cultures may be limited. Future studies can address this issue by conducting cross-cultural examinations to ascertain differences in customers' behavior toward drone delivery across countries. Future studies can also address this issue by adopting longitudinal or experimental designs. Second, this study employed a cross-sectional design, which also limits the validity and generalizability of its findings. Future studies should, therefore, adopt a mixed (qualitative and quantitative) methods approach to gain additional insights. Third, our study examined customers' willingness to adopt drone delivery but not their actual adoption behavior. While studies have shown that adoption intentions lead to actual behavior, future studies should address the intentions—behavior gap. Additionally, it would be interesting to investigate customers' adoption of drone delivery across generations (e.g., millennials versus Generation X), cultures (individualistic versus collectivist cultures and high uncertainty avoidance versus low uncertainty avoidance cultures) and purchase types.

APPENDIX

Crowding [14]
The places I usually shop is crowded
The area I live in is densely populated
In general, the city/town/country I live in are crowded
Social withdrawal tendency [14]
When visiting shops, I might try to avoid other people.
When visiting shops, I would feel talkative to a stranger who happens to be near me (reverse coded).
When visiting shops, I would like to interact with people around me (reverse coded).
Mortality threat [27]
I feel my life is threatened due to COVID 19
I think about death due to COVID 19
I think COVID 19 may take my life
Perceived Severity [29]
The threat of COVID 19 is severe
The threat of COVID 19 is serious
The threat of COVID 19 is significant
Perceived Vulnerability [29]
I am at a risk of contracting COVID19
It is likely that I will contract COVID19
It is possible that I will contract COVID19
Positive attitude towards drone delivery [91, 92]
Drone delivery is a good idea
Drone delivery is a wise idea.
I like the idea of drone delivery
Drone delivery is a pleasant idea.
Drone delivery is appealing.
Negative attitude towards drone delivery [91, 92]
Drone delivery is scary
Drone delivery is uncomfortable
Drone delivery is risky
Drone delivery adoption intention [29]
I intend to use drone delivery in the near future.
I foresee I will use drone delivery in the near future
I plan to use drone delivery in the near future
I will recommend to others to use drone delivery

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