Exploring the influences of personal attitudes on the intention of continuing online grocery shopping after the COVID-19 pandemic

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ABSTRACT

The unprecedented COVID-19 pandemic has brought drastic changes in our daily activities. One of these essential activities is grocery shopping. In compliance with the recommended social distancing standards, many people have switched to online grocery shopping or curbside pickup to minimize possible contagion. Although the shift to online grocery shopping is substantial, it is not clear whether this change would last in the long term. This study examines the attributes and underlying attitudes that may influence individuals' future decisions on online grocery shopping. An online survey was conducted in May 2020 in South Florida to collect data for this study. The survey contained a comprehensive set of questions related to respondents' sociodemographic attributes, shopping and trip patterns, technology use, as well as attitudes toward telecommuting and online shopping. A structural equation model (SEM) was applied to examine the intervening effects of observed as well as latent attitude variables on the likelihood of online grocery shopping after the outbreak. The results indicated that those with more experience in using online grocery shopping platforms were more likely to continue purchasing their groceries online. Individuals with positive attitudes toward technology and online grocery shopping in terms of convenience, efficiency, usefulness, and easiness were more likely to adopt online grocery shopping in the future. On the other hand, pro-driving individuals were less likely to substitute online grocery shopping for in-store shopping. The results suggested that attitudinal factors could have substantial impacts on the propensity toward online grocery shopping.

1. Introduction

Starting in early 2020, the COVID-19 pandemic has brought drastic and unprecedented changes in individuals' travel behavior, routines, and daily activities. Amid this pandemic, there is a significant decrease in in-store sales and a concurrent increase in online shopping due to social distance measures and other mandated preventive regulations (Matson et al., 2021; Richards and Rickard, 2020; Zhao et al., 2020; Hassen et al., 2020; Charlebois, 2020; Donthu and Gustafsson, 2020; Shamshiripour et al., 2020; Chang and Meyerhoefer, 2021). The shift from in-store to online shopping is especially substantial for grocery shopping at the beginning of the pandemic (Shamshiripour et al., 2020). Statistics imply an increasing trend in the online sales during the pandemic. As of August 2019, U.S. online grocery sales totaled $1.2 billion, with an estimated 16.1 million customers who purchased groceries online. By June 2020, the sales total increased to $7.2 billion, and the estimated customers increased to 45.6 million (Forbes, 2020).

However, it is unclear whether the shift to online grocery shopping will persist after the pandemic. In particular, both online and in-store shopping alternatives are accompanied by a number of pros and cons, which make it more difficult to predict the future of consumer's shopping behavior in the post pandemic conditions. In-store shopping offers advantages such as chances for socializing with others, better assessment of the quality of the goods, and no delivery fees. (Raijas, 2002, Hansen, 2006). On the other hand, many people find online grocery shopping a convenient, time-saving, and attractive replacement for in-store shopping (Lee et al., 2017; Raijas, 2002; Huang and Oppewal, 2006; Chakraborty, 2019; Shukla and Sharma, 2018; Forsythe and Shi, 2003, Hansen, 2006).

From a planning perspective, holding to a reliable prediction of online shopping behavior and its trend in near future is of the essence for researchers and stakeholders because it has inevitable impacts in a variety of travel-related and urban domains (Pettersson et al., 2018, Le et al., 2022). The literature documents that online shopping can be

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viewed as a subsequent of information and communication technology (ICT), with similar concepts and complexities involved when addressing the impacts on human travel behavior (Salomon, 1986, Mokhtarian, 1990, Mokhtarian & Meenakshisundaram, 1999, Mokhtarian et al., 2006). In particular, the decision to shop online might affect different aspects of the daily activity-travel plan at individual level, including travel distance (Ferrell 2004; 2005, Shi et al., 2020a;b, Hiselius et al., 2015), trip modes (Suel and Polak, 2017, Bjerkan et al., 2020, Etminani-Ghasrodashti and Hamidi, 2020, Hjorthol, 2009), activity duration and time use (Ding and Lu, 2017, Lee et al., 2017, Weltevreden, 2007, Lachapelle and Jean-Germain, 2019, Farag et al., 2007), and trip chaining behavior (Ferrell, 2005, Farag et al., 2007, Ding and Lu, 2017). Furthermore, and in long run, the concept of e commerce and online shopping might affect urban sprawl and residential relocation (Yang et al., 2021, Nahiduzzaman et al., 2019; 2021, Nanda et al., 2021, Beckers and Verhetsel, 2021). At aggregate level, the adoption of new logistic and supply chain models in the context of smart cities might result in a higher share of commercial vehicles and heavy trucks on the roads, which in turn can lead to adverse impacts on infrastructure quality (e.g., accelerated wear and tear), traffic congestion, air quality and traffic safety (Singh and Santhakumar, 2021, Pan et al., 2019, Badri, 2020, Schade et al., 2018, Seifert and Markoff, 2017).

Given the above motivation, this paper intends to investigate the extent to which people may continue to shop online for groceries after the pandemic. In addition to the pandemic-induced concerns for infection and conforming to the social distancing standards, it is reasonable to expect that individuals' personal and household attributes as well as their preferences, attitudes, and perceptions play a significant role in how they choose to shop for groceries. Further, the practical experience gained during the pandemic might have reshaped their attitudes and their choices for the post pandemic condition. By exploring these variables that potentially contribute to shoppers' behavior toward grocery shopping in a multivariate predictive model, one can expect to gain a more transparent picture of the future online shopping market.

To accomplish this research objective, a consumer survey in view of shopping activities was conducted in May 2020, during which the pandemic exerted its full effect on the public in terms of voluntary and regulatory travel restrictions. The survey focused on adults in south Florida and gathered information on individuals' socioeconomic and demographic attributes, online grocery shopping experience (i.e., frequency of online grocery shopping before and during the COVID-19 pandemic), as well as attitudinal statements towards various aspects of online and in-store grocery shopping such as technology use and perceived benefits and concerns for shopping grocery online. A structural equation model (SEM) was then applied to examine the intervening effects of observed as well as latent attitude variables on the likelihood of online grocery shopping after the outbreak.

The rest of this paper lays out as follows: Section 2 presents a summary of the current state of the literature in terms of online shopping. In particular, we merely focus on predictive analytics and contributing factors at a personal level. Section 3 elaborates data collection and survey design. Descriptive statistics come next, where we explore consumers' responses to a handful of online-shopping related questions. Section 4 lays out the theory of structural equation models, where we discuss the suitability of the SEM model to the purpose of this study. Model results and discussion are presented in the next section, followed by potential policy implications of our findings. Finally, we conclude the paper by presenting the major highlights, discussing limitations, as well as providing recommendations on further research avenues.

2. Literature review

The review of literature for this study consists of two parts. Findings from the literature on online grocery shopping behavior before the pandemic are first discussed, followed by discussions on studies investigating the impacts of the COVID-19 outbreak on online grocery

shopping. Explicitly, we focus on research efforts that used predictive analytical approaches to estimate online shopping behavior at individual level as well as identifying significant contributing factors.

2.1. Online grocery shopping

Several studies investigated factors that contribute to the adoption of online grocery shopping (OGS) or electronic grocery stores (EGS). Raijas (2002) explored the characteristics of people who used EGS in Finland by analyzing data from a pilot survey on grocery shopping behavior. They showed that the most significant factors encouraging online grocery shopping included the reluctance to do product selection, time-saving, and easiness of online grocery shopping. On the other hand, challenges in finding the right products, higher prices, and being unsure about the quality were the major disincentives for online grocery shopping. These issues were especially significant for inexperienced online grocery shoppers.

Driediger and Bhatiasevi (2019) examined factors that affect online grocery shopping behavior in Thailand using an in-person survey. The results showed that perceived easiness for online grocery, perceived usefulness (i.e., improve their quality of life), and perceived enjoyment during the shopping experience have positive impacts on the adoption of online grocery shopping. Bauerová and Klepek (2018) found similar results from an online survey conducted in the Czech Republic. They showed that the perceived easiness of online grocery shopping has a positive impact on the perceived usefulness, which subsequently influenced the intention of using OGS. Other studies presented similar results (Chakraborty, 2019; Shukla and Sharma, 2018).

Hansen (2006) analyzed factors influencing grocery shopping behavior by those who have online grocery shopping experiences based on data from an online survey conducted in Denmark and Sweden. The results showed that avoidance of physical effort associated with in-store shopping encouraged the repurchase of products online. In contrast, the joy of in-store shopping and challenges with online grocery shopping (e. g., electronic grocery shopping is difficult, receiving items delivered at home is not convenient) reduced individuals' tendency toward frequent online grocery shopping.

In another study by Mortimer et al. (2016), the intention to shop groceries online was examined using data from an online survey. They analyzed the effects of perceived risks (e.g., feeling secure purchasing online with credit cards and providing personal information) on their intention to repurchase online. The findings revealed that satisfactory experiences with OGS websites positively influenced these individuals' trust and intentions to repurchase from the websites. However, perceived risks associated with online grocery shopping mediated the effect of trust on the intention to repurchase for infrequent shoppers. The results indicated that risk perceptions on online grocery shopping platforms intensify irregular shoppers' concerns for these platforms and discourage them from becoming frequent customers. Similar findings were presented by other studies (Min et al., 2012; Anschuetz, 1997).

2.2. The impact of the COVID-19 pandemic on online grocery shopping behavior

There has been a general shift toward online grocery shopping since the beginning of the Covid-19 outbreak in early 2020. And as such, many studies have sought to investigate the changes in consumers' online grocery shopping behavior due to the Covid-19 pandemic, and the factors affecting the adoption, usage, satisfaction, preference, intention, and stickiness of consumers' online grocery shopping behavioral changes. It should be noted that previous studies were conducted at different stages of the pandemic and in different countries, with varying degrees of lockdown protocols depending on the seriousness of the health crisis or the vaccination rates of residents in their states or countries.

In the initial stages of the pandemic and before the availability of

vaccines, consumers chose online grocery shopping primarily to preserve their health or that of their loved ones (Baarsma & Groenewegen, 2021; Chang & Meyerhoefer, 2021; Eriksson & Stenius, 2022; Grashuis et al., 2020; Lo et al., 2021; Mercatus, 2020; Shamshiripour et al., 2020). In Taiwan, for instance, an additional COVID-19 case in early 2020 increased Ubox (an online food shopping platform) sales by 5.7% and weekly customers by 16% (Chang & Meyerhoefer, 2021). In the Netherlands, an additional local hospital admission increased online grocery shopping app traffic by 7.3% in the first eight months of the pandemic (Baarsma & Groenewegen, 2021). In Qatar, Hassen et al. (2020) showed a surge in online grocery shopping frequency amid the pandemic compared to pre-pandemic conditions. The results indicated that young people and those with a university degree have a positive inclination toward online grocery shopping. It was noted that some customers were reluctant to do online grocery shopping because they could not check the freshness of the products.

In the US, a choice experiment design showed that increasing Covid-19 cases negatively affected preferences to shop inside the grocery store (Grashuis et al., 2020). Ellison et al. (2021) conducted a panel survey with 1,370 households in the U. S. periodically four times amid the pandemic from March to April of 2020. The results showed about a 50% increase in online grocery shopping adoption from the first wave to the fourth wave of data collection. Similar findings were reported by other studies (Shamim et al., 2021; Li et al., 2020). However, in the middle and later months of 2021 when Covid-19 safety concerns had significantly diminished due to widespread vaccination and lockdown protocols had been lifted in most US states, other reasons for online grocery shopping seemed to have taken priority over health concerns (Mercatus, 2021; Warganegara and Hendijani, 2022). For instance, Warganegara and Hendijani (2022) showed that, in the third quarter of 2021, health risks did not show significant effects on the purchasing intent of 300 Indonesian residents. Mercatus (2021) reported that convenience and time savings were now (in 2021) the top two reasons for the change in consumers' online shopping preference in the US.

The impact of attitudinal factors online grocery shopping behavior has been examined across the Covid-19 timeline. Perceived usefulness and favorable attitude toward online shopping have been shown to be strong drivers of online grocery shopping usage and intention (Bezirgani & Lachapelle, 2021; Li et al., 2020; Qi et al., 2021; Tyrväinen & Karjaluoto, 2022; Warganegara and Hendijani, 2022). Perception of low complexity or ease of online grocery shopping usage encouraged online grocery shopping usage, intention, and satisfaction (Alaimo et al., 2020; Tyrväinen & Karjaluoto, 2022; Warganegara and Hendijani, 2022). Perceived risk or insecurity in using technology or online shopping websites tended to negatively affect online grocery shopping usage and intention (Titiloye et al., 2023; Tyrväinen & Karjaluoto, 2022). Technology savviness, shopping enjoyment, and having a pro-environment attitude were drivers of choosing home delivery and curbside pickup options over the in-store grocery shopping alternative (Titiloye et al., 2023). Social influence or pressure has been found to affect online grocery shopping usage and intention (Tyrväinen & Karjaluoto, 2022; Warganegara and Hendijani, 2022), while subjective norm tended to affect online grocery shopping intention (Bezirgani & Lachapelle, 2021; Tyrväinen & Karjaluoto, 2022). However, Qi et al. (2021) examined shopping intentions among 491 Chinese residents in mid-2021 and found no significant effect between subjective norm and online grocery purchase intentions.

Regarding socio-demographic factors, it has been shown that younger individuals have a higher tendency to engage in online grocery shopping than older ones (Eriksson & Stenius, 2022; Hassen et al., 2020; Lo et al., 2021; Titiloye et al., 2023). Since women in general tended to be observant of health safety practices than men (Shamim et al., 2021; Truong & Truong, 2022), women (including women aged 45 and above) tended to be adopters than other groups (Eriksson & Stenius, 2022; Titiloye et al., 2023). Education and income are positively associated with online grocery shopping usage (Eriksson & Stenius, 2022; Hassen et al., 2020; Lo et al., 2021), and those with higher educational levels tended to be more satisfied with their online shopping experience than others (Alaimo et al., 2020). Also, full-time workers and those living in larger household sizes or households with children had a higher tendency to engage in online grocery shopping (Eriksson & Stenius, 2022; Lo et al., 2021; Titiloye et al., 2023). However, results on shopping expenditure seem different for socio-demographic variables, as Truong & Truong (2022) found online grocery shopping expenditure to be positively related with age group, negatively related with education, and not significantly related with income and number of children in the household. The results related to expenditure may be related to the level of utility different groups attached to avoiding in-store shopping depending on the level of their health concerns. For example, the older population were more cautious about their health, and may have been willing to spend more money on online grocery purchases than their younger counterparts.

One study has sought to estimate the "stickiness" (that is, the extent to which online grocery shopping usage will stabilize or increase after the pandemic) of online grocery purchase behaviors by asking respondents if they were ordering groceries online more often compared to before the start of the pandemic and expecting to retain or increase the proportion of their grocery shopping done online looking one year to the future (Abou-Zeid et al., 2021). The result of the binary logit analysis indicates that shoppers younger than 65 years, who traveled to the store using multiple transportation modes, and located in places with high online grocery service availability were more likely to hold or increase their already elevated online grocery shopping usage.

3. Survey design and data

Data for this study were obtained from an online SP-RP survey targeting adults 18 years and older in South Florida in the United States. This survey was conducted in May 2020 amid the COVID-19 pandemic when the stay-at-home order was in full effect in the study area. The survey was implemented through the Qualtrics platform, and the sampling stratifications were based on the 2018 American Community Survey (ACS) in terms of age, gender, income, ethnicity, and race. A total number of 1,028 complete responses were collected.

The survey gathered information on the respondents' socioeconomic and demographic attributes, work arrangements, daily travel patterns, and preferences for shopping and telecommuting. While telecommuting attitudes might look irrelevant at first sight, the literature suggests that ICT applications (in any form including telecommute, online shopping, autonomous vehicles, ride-share, etc.) tend to impact similar contexts of activity travel behavior (e Silva et al., 2017, Le et al., 2022) and therefore, it is reasonable to assume that any revealed information or attitudes towards on specific ICT domain can contribute to another either as a measure of familiarity or an index of technology embracement. Table 1 illustrates the descriptive statistics of the survey data.

To understand how the pandemic changed survey respondents' shopping behavior, respondents were asked about their online grocery shopping frequency (for pickup and delivery) before and during the COVID-19 pandemic. The choices were defined as:

(1) *Never*
(2) *Once every month or less*
(3) *Once every two weeks*
(4) *Once every week*
(5) *A few times a week*
(6) *Every day*

Fig. 1 shows the comparison between the frequencies of online grocery shopping for delivery before and during COVID-19. As shown, about 65% of the respondents had never experienced online grocery shopping for delivery before the pandemic. This percentage decreased by 12% percentage point during the pandemic to 53%. Before the

Table 1
Descriptive statistics.

Attributes		Share	2018 ACS
Age	18–34	31.0%	27.0%
	35–54	37.0%	35.0%
	55+	32.0%	38.0%
Household Income	Less than $25 K	25.9%	46.4%
	$25 K - $50 K	24.1%	
	$50 K - $75 K	15.7%	28.6%
	$75 K - $100 K	12.9%	
	$100 K - $125 K	7.8%	25.0%
	$125 K - $150 K	6.0%	
	$150 K-200 K	3.8%	
	$200 K or more	3.8%	
Gender	Female	55.8%	52.0%
	Male	44.2%	48.0%
Education Level	Less than High School	3.1%	–
	High School Graduate	17.4%	–
	Some College, No Degree	21.1%	–
	Associate Degree	12.3%	–
	Bachelor's Degree	27.4%	–
	Master's degree	13.4%	–
	Doctorate Degree	2.7%	–
	Professional Degree	2.5%	–
Race	White	72.4%	72.4%
	Black or African American	16.6%	19.8%
	Asian	2.3%	2.6%
	American Indian American Indian or Alaska Native	0.9%	5.2%
	Native Hawaiian or Pacific Islander	0.6%	
	Two or more Races	7.2%	
Employment Status	Full-Time	45.9%	–
	Part-Time	16.5%	–
	Self-Employed	6.2%	–
	Unemployed	31.3%	–
Household Composition	Living with significant other	44.6%	–
	Living with children	31.8%	–
	Living with grandparents	2.0%	–
	Livings with parents	19.8%	–
	Living with roommates	6.5%	–
	Other	6.0%	–
Number of Non-working, Non-student Adults	0 adults	62.2%	–
	1 to 3 adults	36.6%	–
	More than 3 adults	1.3%	–
Household Size	1 Person	14.8%	–
	2 Persons	27.2%	–
	3 Persons	15.5%	–
	4 Persons	13.2%	–
	5 Persons	5.6%	–
	6 Persons	2.3%	–
	7 Persons	0.5%	–
	8 Persons	0.2%	–
	9 Persons	0.1%	–
	10 and More Persons	0.3%	–
	Missing	20.2%	–
Household Structure	Living with children only	9.6%	
	Living with children and parents	2.7%	
	Living with roommates only	4.5%	
	Living with significant other only	25.4%	
	Living with significant other and children	15.8%	
	Living with significant other and children and parents	1.3%	
	Livings with parents only	12.5%	
	Other	10.3%	
	missing	17.9%	
Telecommuting Frequency	Do not have the telecommuting option	50.5%	–
	Never	15.2%	–
	A few times per year	1.6%	–
	A few times per month	3.8%	–
	Once a week	3.2%	–
	Twice a week	2.4%	–

Table 1 (*continued*)

Attributes		Share	2018 ACS
	3 days a week	2.5%	–
	4 days a week	2.5%	–
	5 days a week	11.7%	–
	6 days a week	1.9%	–
	7 days a week	4.7%	–

pandemic, only 15% of the respondents shopped online for groceries at least once a week. This percentage also increased during the pandemic and reached 23%. Fig. 1 illustrates that COVID-19 changed individuals' shopping behavior due to voluntary or enforced social distancing practices. Similar patterns were reported by other studies, suggesting a substantial increase in the percentage of individuals who adopted online grocery shopping for the first time during the pandemic (Ellison et al., 2021; Hassen et al., 2020; Shamim et al., 2021; Shamshiripour et al., 2020).

Based on their online grocery shopping experience, survey respondents were also asked how likely they will use online grocery shopping after COVID-19 is no longer a threat, compared to their experience before the pandemic. The choices were outlined as follows:

(1) *Much less than before*
(2) *Somewhat less than before*
(3) *About the same*
(4) *Somewhat more than before*
(5) *Substantially more than before*

Fig. 2 and Fig. 3 summarize the reported intention for increasing or reducing shopping grocery online for delivery after the pandemic (expressed in the above five ordinal scales), plotted against actual online grocery shopping frequencies (in relative scales by time periods) before the pandemic (Fig. 2) and during the pandemic (Fig. 3). Fig. 2 shows that pre-pandemic infrequent online grocery shoppers (once every month or less) tended to remain uninterested in online grocery shopping after the pandemia. On the other hand, frequent or habitual online grocery shoppers (once every week or more) are likely to buy groceries online even more frequently in the future. Similarly, as shown in Fig. 3, infrequent shoppers during the pandemic showed lower interest in online grocery shopping in the future than frequent online grocery shoppers. While viewing Figs. 2 and 3, the correlation between the two should be noted. For example, people who had shopped for groceries online frequently before the pandemic probably did online grocery shopping with the same or higher frequencies during the pandemic.

The findings shown in Figs. 2 and 3 are consistent with Shamshiripour et al. (2020), who also investigated the propensity of online grocery shopping after the pandemic in the short- (a few months after the pandemic is over) and long-term. Their results indicated that there could be a more positive inclination in public toward online grocery shopping in the long term compared to before the pandemic. However, they did not consider the role of individuals' shopping behavior before and during the pandemic in future online grocery shopping preferences.

The survey also contains questions to solicit respondents' attitudes toward online grocery shopping. Results of respondents' responses to these questions are summarized in Fig. 4. A high percentage of respondents believed that interaction with online grocery shopping websites is easy; online grocery shopping is convenient and requires minimal physical effort. Interestingly, respondents are less likely to indicate that online grocery shopping requires minimal mental effort. This might indicate that choosing between many products can be exhausting and complicated for some people (Raijas, 2002; Hansen, 2006). Besides, most online grocery shopping websites require registration to complete the purchase, which might be inconvenient for some shoppers. Some people who are less experienced in online grocery shopping may also
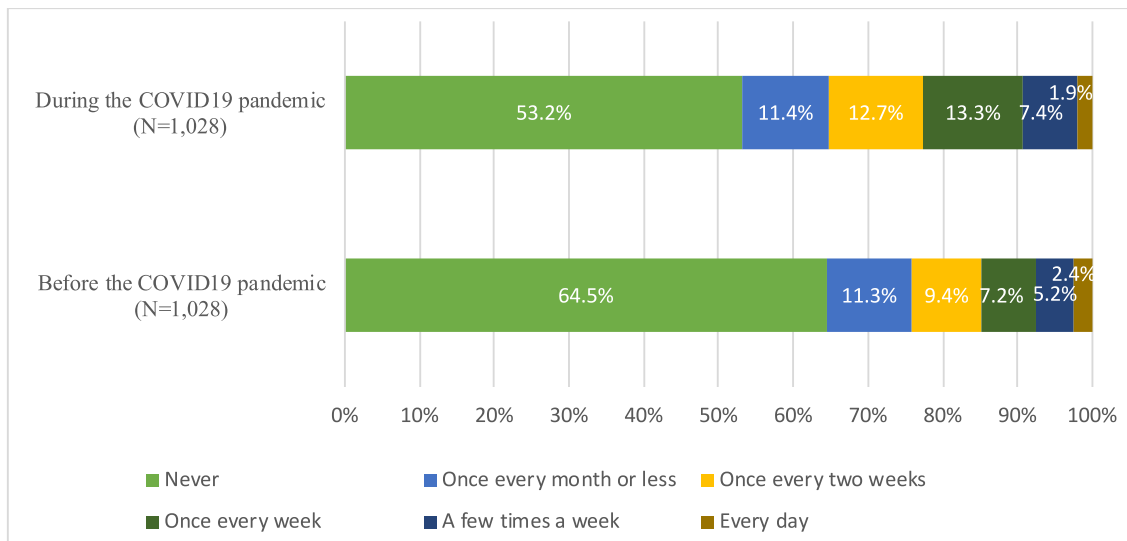
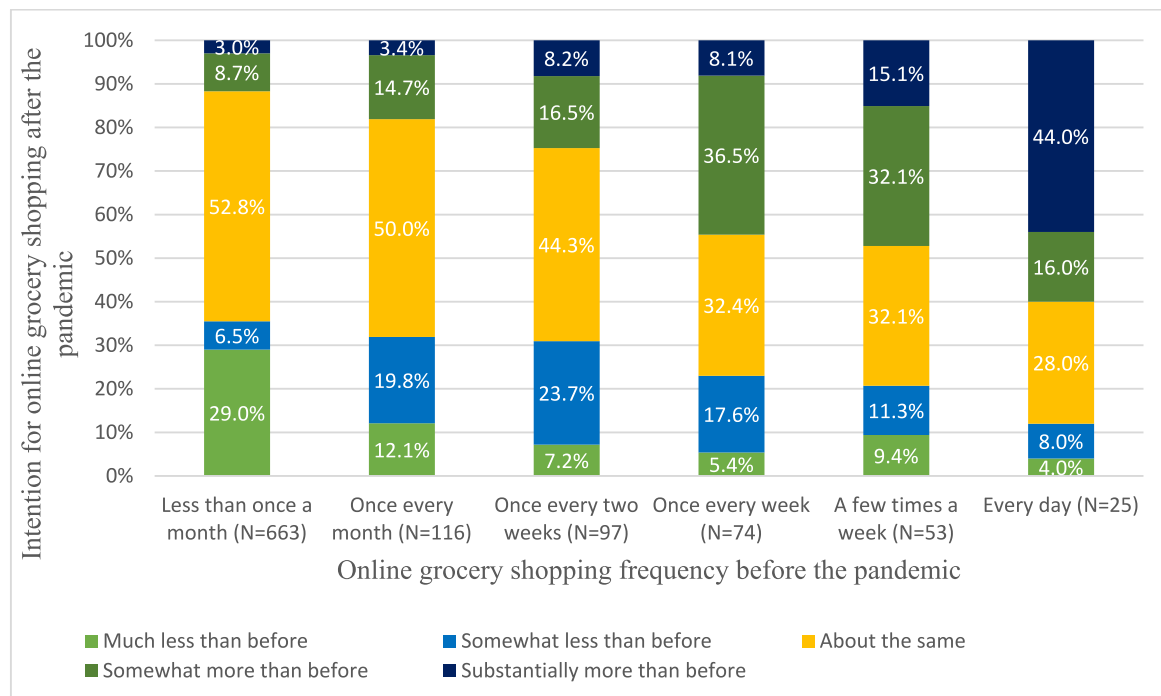**Fig. 1.** Online grocery shopping frequency before and during the COVID-19 (N = 1,028).

Fig. 2. Reported intention of online grocery shopping after COVID-19 by pre-pandemic online grocery shopping frequency (N = 1,028).

consider the checkout process lengthy and complicated.

Fig. 5 presents the pattern observed in the respondents' attitudes toward technology adoption. Compared to other attitudinal indicators, a high percentage of respondents liked trying new and different things, and they believed that they knew more than others about the latest technologies on the market. On the other hand, when it comes to purchasing technological products, the majority of the respondents disagreed that they would purchase new products regardless of their prices.

Fig. 6 shows the observed pattern in driving-related attitudes. As expected, most respondents did not enjoy driving in heavy traffic. In contrast, most respondents enjoyed the freedom of private vehicle ownership and considered driving a relaxing way to commute. This group of individuals could be more reluctant than others to do online grocery shopping for delivery, as they may enjoy driving to the stores.

Attitudes toward telecommuting are also explored in this study. The

underlying reason for this is two-fold: 1) First, the literature suggests that different manifestations of information and communication technology (ICT) may have similar impacts on activity travel behavior at individual level (Le et al., 2022). This might stem from the fact that different forms of ICT adoption and impacts are rooted in the fundamental technology welcoming attitudes and the perception of benefits at individual level, regardless of the specific form. 2) It might be reasonable to assume that attitudes towards one form of ICT can be used either as a surrogate measure of familiarity or a practical manifestation of tech-welcoming attitude. Authors believe that this provides us with compelling evidence to analyze telecommuting attitudes as they may unveil further information about individual's overall attitudes toward technology. Fig. 7 shows that the majority of the respondents perceived video calling as a suitable alternative to in-person meetings. On the other hand, fewer respondents would enjoy working from home, which
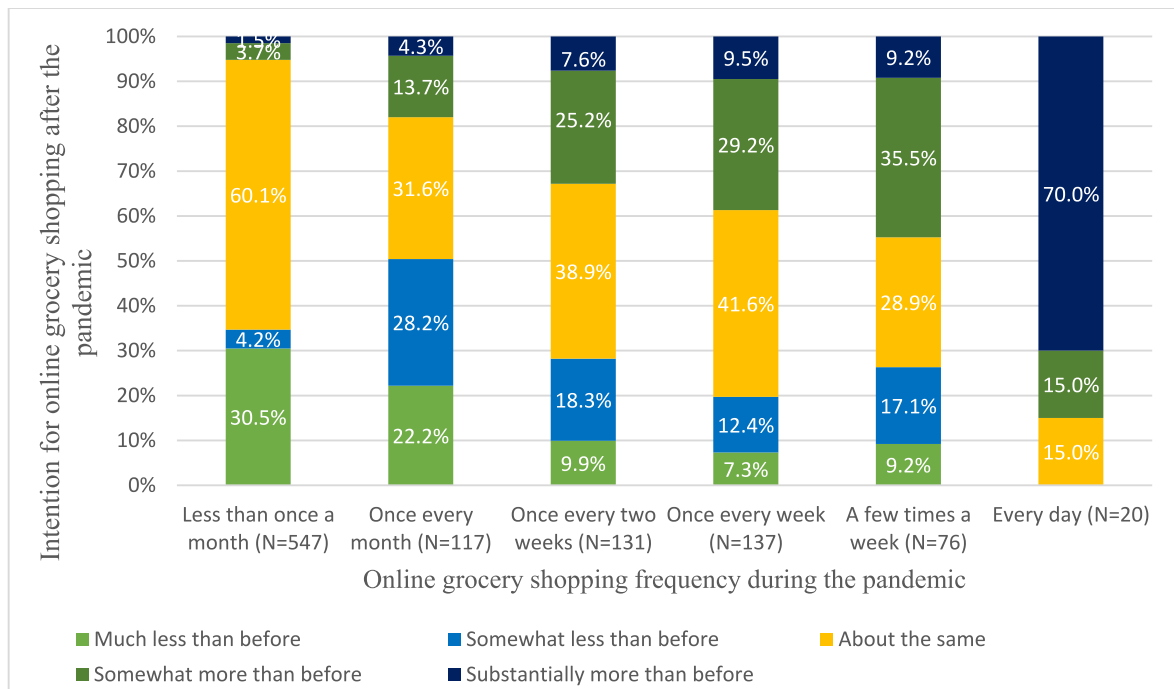
Fig. 3. Reported intention of online grocery shopping after COVID-19 by during-pandemic online grocery shopping frequency (N = 1,028).
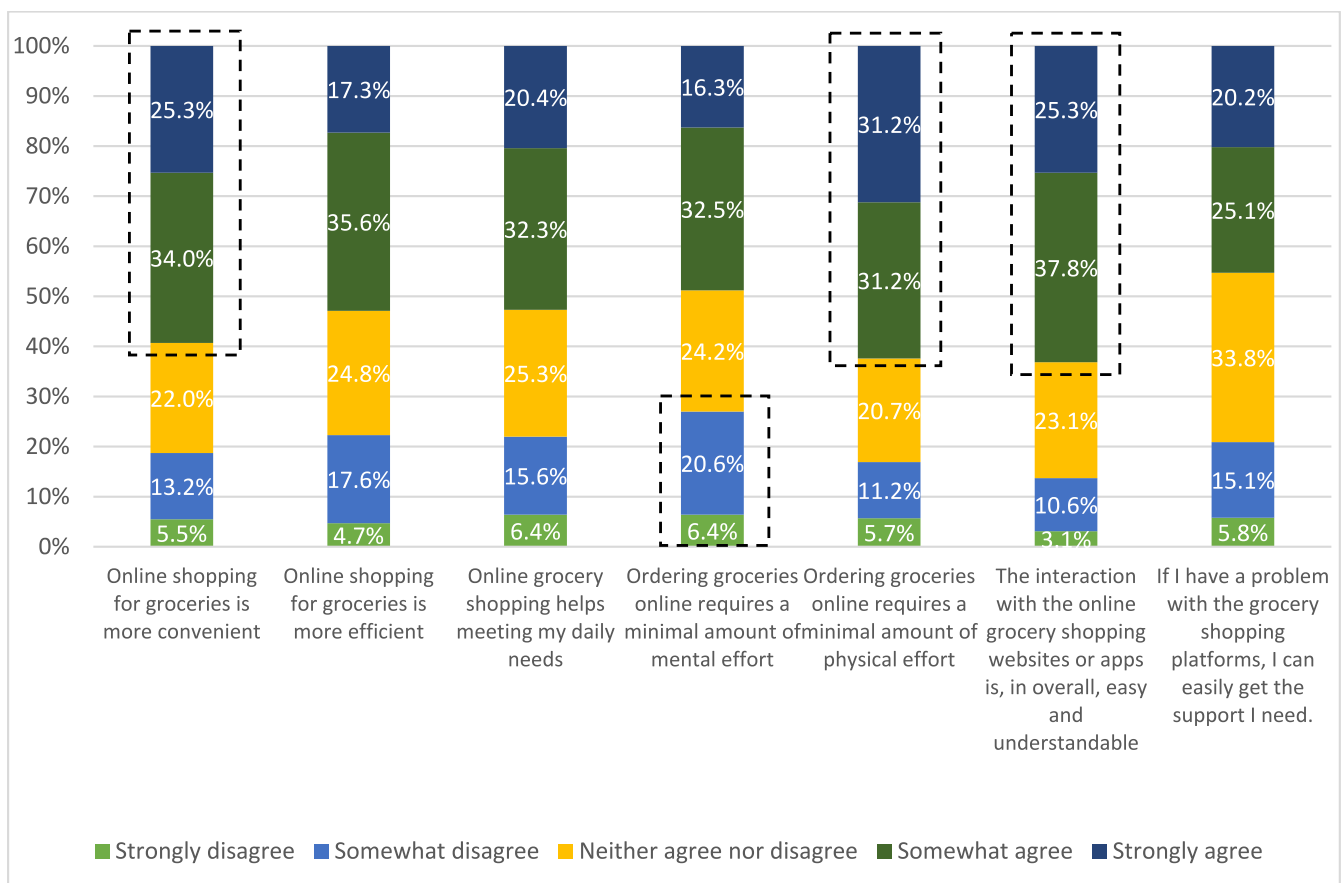

Fig. 4. Attitudes toward online grocery shopping (N = 545).

could be because of distractions and lack of the necessary supplies and technology products (e.g., high-speed internet connection, office desks, scanners, printers).

4. Modeling approach

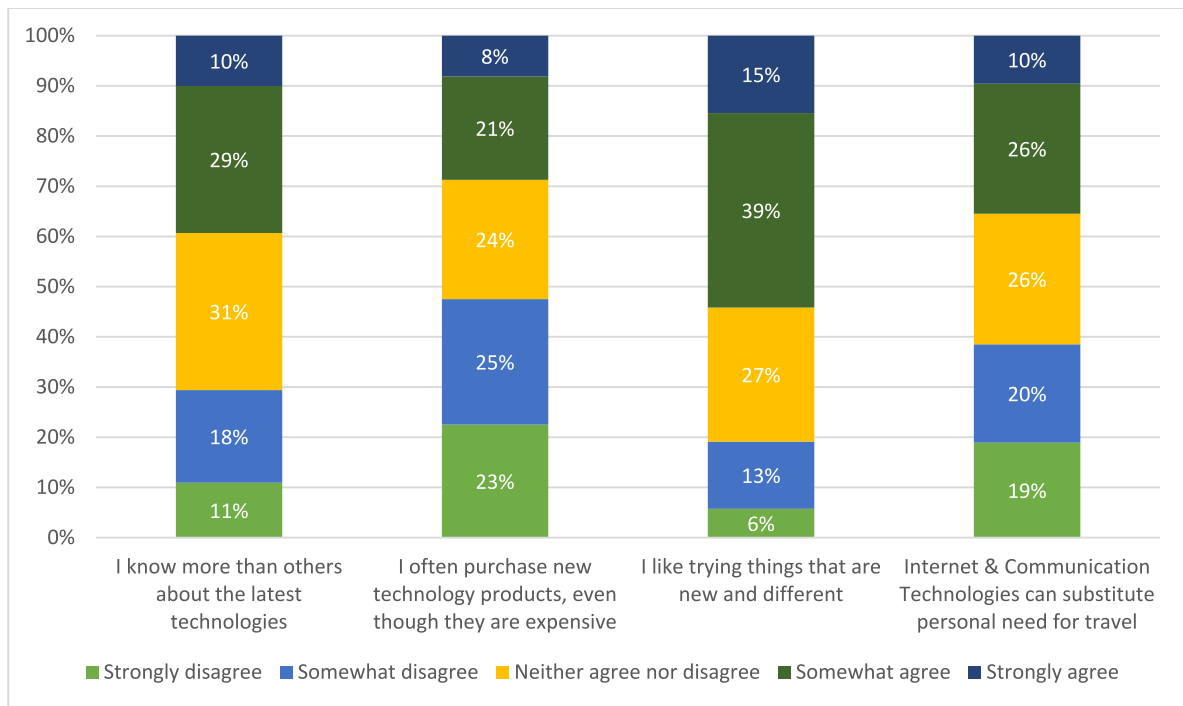Structural equation modeling (SEM) was employed to analyze the

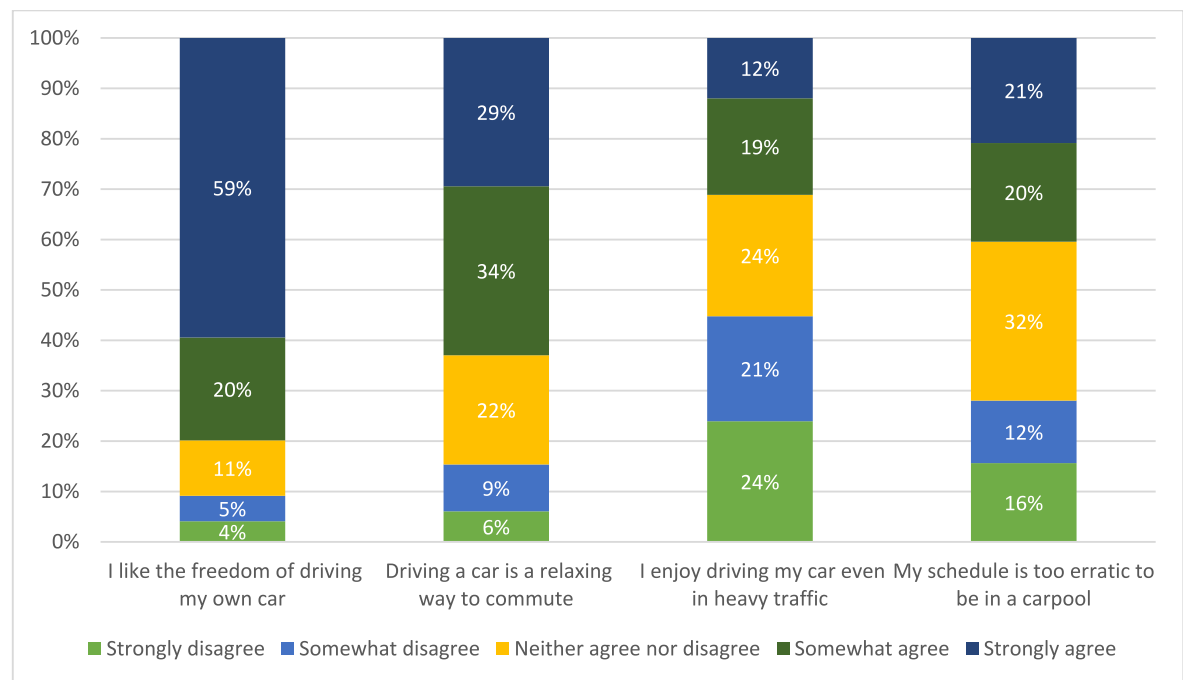**Fig. 5.** Attitudes toward technology adoption (N = 888).

Fig. 6. Attitudes toward driving (N = 710).

survey data for this study. SEM is a widely used statistical tool in certain cases where several endogenous (i.e., dependent) variables are to be predicted simultaneously, or when the analyst intends to measure latent variables that simultaneously serve as predictors in the model (Bollen, 1989, Bollen and Long, 1993, Golob, 2003, Schumacker and Lomax, 2004, Kaplan, 2008). In the former case, SEM helps account for different dependency structures between endogenous variables including correlation, direct one-way causal effect of one endogenous variable on another, or a direct feedback (mutual two-way) impact. In the latter

case, SEM prevents random measurement errors in estimating latent variables, which further results in more consistent and unbiased estimates (Christ et al., 2014). Several successful applications of SEM in different aspects of travel behavior and more specifically online shopping activities have been documented in the literature (Njite and Parsa, 2005; Farag et al., 2007; Cao et al., 2012; Irawan and Wirza, 2015; Rita et al., 2019; Dastane, 2020; Prasetyo and Fuente, 2020; Koch et al., 2020; Tarhini et al., 2021; Sarker et al., 2023).

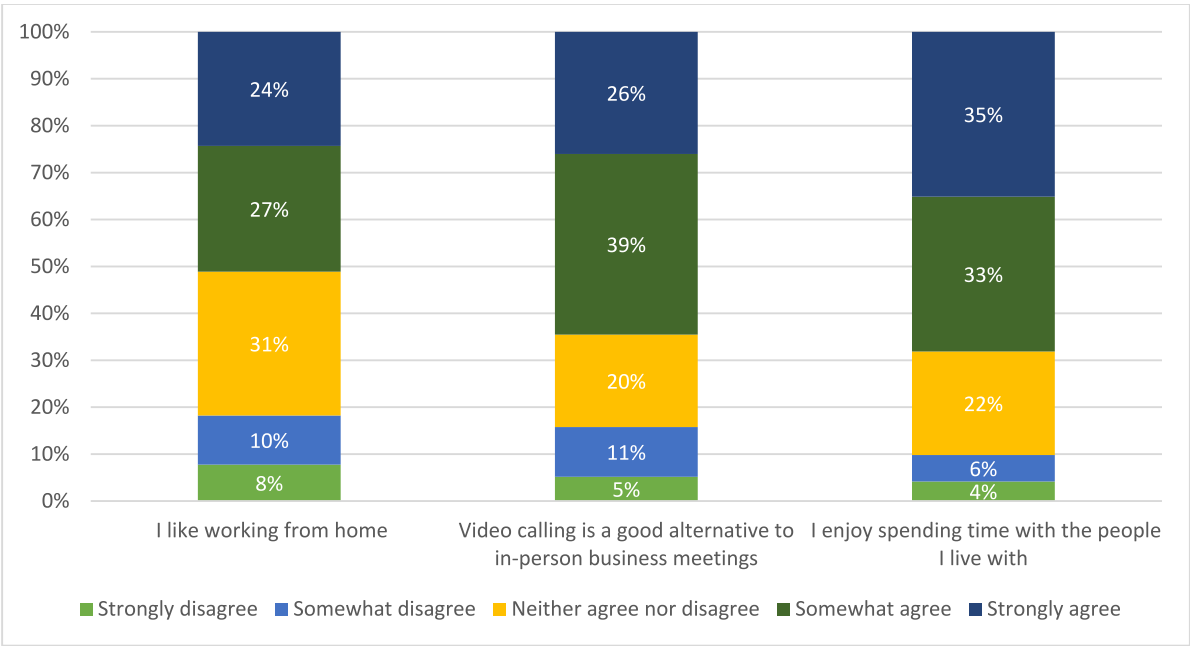Theoretically speaking, SEM is a multivariate statistical method that

Fig. 7. Attitudes toward telecommuting (N = 888).

uses covariance matrices to simultaneously test the existing causal relationships among a set of variables. In technical terms, variables could be endogenous (i.e., variables to be predicted, but may also be used as predictors for other endogenous variables in the model), exogenous (i.e., observed variables that are only used as predictors), and latent variables (unobserved variables that are regressed on other observed variables in the model and maybe predicted or be used as a predictor). Consequently, SEM consists of two concurrent components, namely the measurement
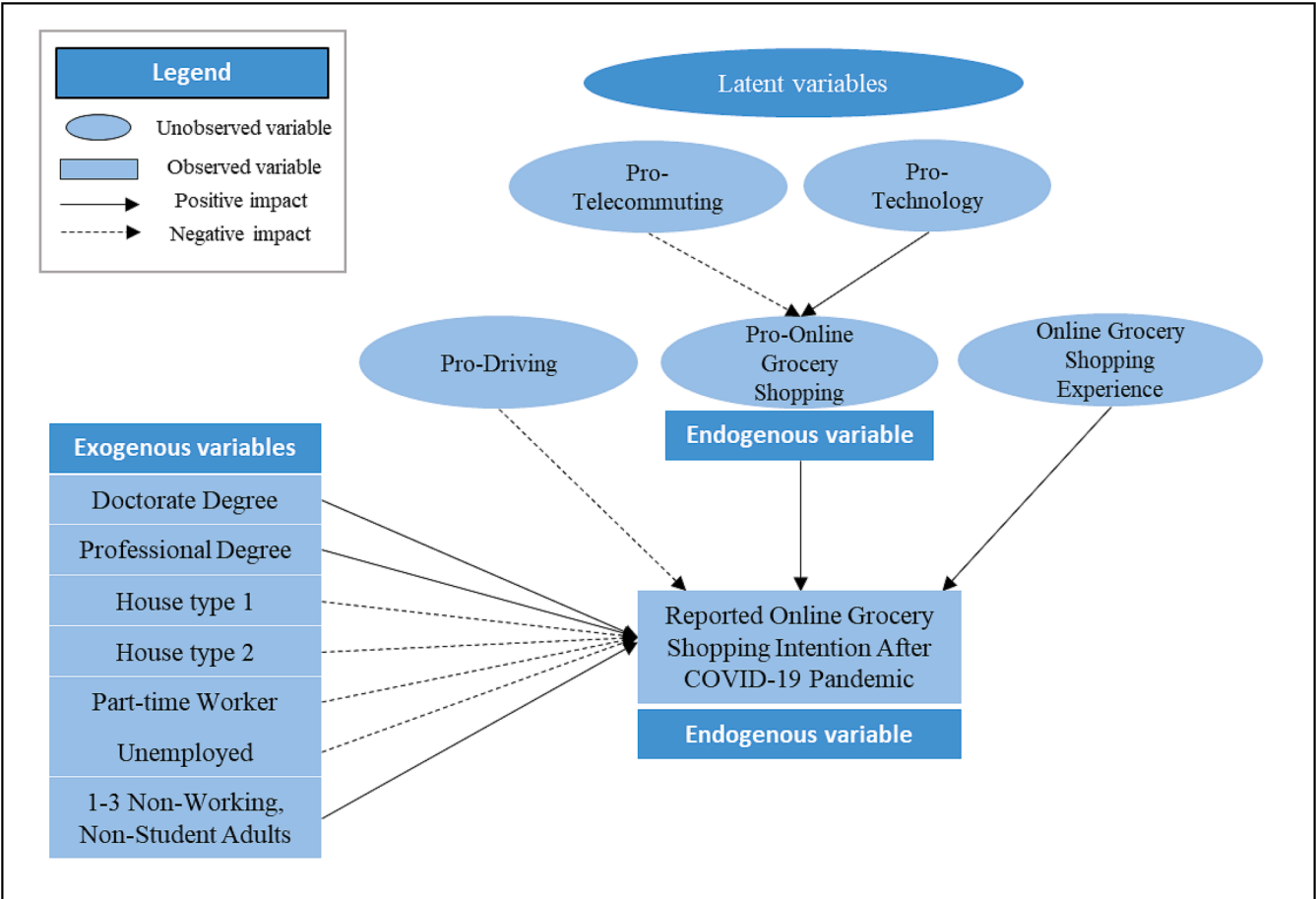

Fig. 8. Model path diagram.

model and the structural model. Measurement models regress latent variables (LVs, also referred to as latent factors) on a set of attitudinal indicators. Structural models estimate relationships between dependent (endogenous) variables and covariates, including observed exogenous variables (SED attributes) and LVs.

SEMs are usually accompanied by a schematic view, referred to as the path diagram. The path diagram demonstrates the relationships between the variables (Fig. 8). As can be seen, our model uses a simple structure where there is only one observed endogenous variable, "intended frequency of online grocery shopping after the pandemic". The observed exogenous variables include a variety of socio-economic and demographic attributes, while 5 different latent factors were measured based on likert scale attitudinal statements and simultaneously used as predictors in the structural model.

It should be noted that the dependent variable in this study (intention for increasing or reducing online grocery shopping after COVID-19) has an ordinal nature. Some research efforts in the literature supported the idea that an ordinal variable maybe treated as a continuous variable should it consist of numerous categories (usually four or more) (Göb et al., 2007; Byrne, 2013; Rhemtulla et al., 2012; Bentler and Chou, 1987). However, this is subject to further limitations such as an approximately normal distribution of categories or the symmetry of thresholds, which do not seem to stand true in our case. On the other hand, there are certain estimation methods for ordinal endogenous variables in SEM such as the Diagonally Weighted Least Square (DWLS) (Muthén and Muthén, 2007, Mîndrilă, 2010, Rhemtulla et al., 2012, Asgari and Jin, 2017). Hence, the dependent variable here is declared as an ordered variable and the coefficients were estimated using a DWLS approach.

The measurement model (first step) can be expressed as follows:

$$Y = \beta y + \omega \tag{1}$$

Where,

Y: The vector of LVs,

β: The matrix of coefficients of attitudinal indicators on LVs,

y: The vector of attitudinal indicators,

ω: The error terms vector.

The mathematical construct of a structural model, which examines the relationship between the dependent variable and explanatory variables (identified latent variables as well as observed exogenous variables), can be formulated as below:

$$U = [03B8]X + \tau Y + \epsilon \tag{2}$$

Where,

U: Dependent variable (Reported online grocery shopping intention after COVID-19),

θ: The coefficients matrix of the direct impacts of exogenous variables on the endogenous variable,

X: The vector of exogenous variables (socioeconomic and demographic characteristics),

τ: The coefficients matrix of the direct impact of LVs on the endogenous variable,

Y: The vector of LVs,

ϵ: the error terms vector.

The model was estimated using the latent variable analysis (lavaan) library in R using a Diagonally Weighted Least Square estimation approach for ordinal variables.

5. Model results

The model performance results are presented in Table 2. The Chi-Square test is a traditional performance measure assessing the "differences between the observed and fitted covariance matrices "(Hooper et al., 2008). Small (insignificant) p-values are generally desirable, but the chi-square test is sensitive to sample size. The p-value of the model suggests that there is not enough evidence to reject that the difference

Table 2
Summary of model performance measures.

Criteria	Value	Cut-off criterion	Additional information
Chi-Square	1262.66	–	P-value = 0.00 DoF = 317
Root Mean Square Error of Approximation (RMSEA)	0.05	RMSEA < 0.06	90% CI = [0.05, 0.06]
Standardized Root Mean Square Residual (SRMR)	0.05	SRMR < 0.08	NA
Comparative Fit Index (CFI)	0.94	CFI > 0.90	NA
Tucker Lewis index (TLI)	0.96	TLI > 0.95	NA

between the observed and fitted covariance matrices is insignificant (Shi et al., 2019). Hence, we can conclude that the model had acceptable performance. The Root Mean Square Error of Approximation (RMSEA) specifies the "discrepancy between a hypothesized and a perfect model" (Xia and Yang, 2019). The model showed an acceptable performance regarding this measure, indicating a convergence fit to the data. Standardized Root Mean Square Residual (SRMR) is an "absolute fit index measuring the average of the standardized residuals between the observed and model-implied covariance matrices" (Chen, 2007; Bentler, 1995). Considering the value of SRMR, we can conclude that the average magnitude of the discrepancies between observed and fitted covariance matrices is acceptable. The Comparative Fit Index (CFI) and the Tucker Lewis index (TLI) are "incremental fit indices comparing the fit of the hypothesized model with that of a baseline model (i.e., a model with the worst fit)" (Xia and Yang, 2019). Contrary to the Chi-square test, CFI and TLI are not sensitive to sample size (Xia and Yang, 2019, Fan et al., 1999). As shown in Table 2, the values of CFI and TLI suggest the better performance of the fitted model than the baseline model.

The structure of the SEM developed for this study is presented in Fig. 8. Significant latent factors and their indicators, as well as SED characteristics, are illustrated.

5.1. Measurement model results

Table 3 shows the results of the measurement model. In total, five latent attitudes were identified, each with at least three indicators (which were significant at the 99% significance level). The latent attitudes were significant in terms of both the Z-value and the standardized factor loadings (the minimum value considered for the factor loading is 0.5).

The first attitude, labeled as *online grocery shopping experience*, is related to online grocery shopping frequency (for both delivery and pickup) before and during the COVID-19 pandemic. The second attitude, which is defined as *pro-online grocery shopping*, reflects the positive attitude toward online grocery shopping's efficiency, convenience, usefulness, and easiness.

The third attitude, labeled as *pro-technology*, refers to the positive tendency toward technology use. This attitude is related to one's knowledge about the latest technology, prior purchases of new technological products regardless of their prices, the inclination to try new and different things, and perception of Internet and Communication Technologies (ICT) as a potential substitute for travel. The *pro-driving* factor reflects the inclination toward private cars due to the convenience and the joy of driving. The *pro-telecommuting* factor denotes the respondents' positive attitude toward telecommuting.

5.2. Structural model results

5.2.1. Attitudinal factors

Table 4 presents the results of the structural model. In terms of attitudinal factors, the results showed that online grocery shopping experience (i.e., higher frequency of online grocery shopping before and during the COVID-19 pandemic) has a positive impact on more frequent

Table 3
Results of Measurement Model.

Attitude	Indicators (answer choices to the attitude questions)	Factor Loading	Z-Value
Online Grocery Shopping Experience	Frequency of online grocery shopping for delivery-Before COVID-19	1.00	–
	Frequency of online grocery shopping for pick up-Before COVID-19	1.07***	23.91
	Frequency of online grocery shopping for delivery-During COVID-19	1.23***	17.51
	Frequency of online grocery shopping for pick up-During COVID-19	1.46***	16.41
Pro-Online Grocery Shopping	Online shopping for groceries is more efficient	1.00	–
	Online shopping for groceries is more convenient	0.96***	27.33
	Online grocery shopping helps meeting my daily needs	1.01***	26.85
	Ordering groceries online requires a minimal amount of mental effort	0.86***	22.04
	Ordering groceries online requires a minimal amount of physical effort	0.91***	20.94
	The interaction with the online grocery shopping websites or apps is, overall, easy and understandable	1.02***	23.30
	If I have a problem with the grocery shopping platforms, I can easily get the support I need.	0.81***	21.44
Pro-Technology	I know more than others about the latest technologies.	1.00	–
	I often purchase new technology products, even though they are expensive	1.12***	14.66
	I like trying things that are new and different	0.84***	12.29
	Internet & Communication Technologies can substitute personal need for travel	0.88***	11.33
Pro-Driving	I like the freedom of driving my own car	1.00	–
	Driving a car is a relaxing way to commute	0.78***	10.02
Pro-Telecommuting	I like working from home	1.00	
	Video calling is a good alternative to in-person business meetings	1.29***	11.08
	I enjoy spending time with the people I live with	1.00***	9.57

*, **, *** respectively denote significance at 0.1, 0.05, and 0.01 level.

Table 4
Results of Structural Model.

Dependent variable	Explanatory variables	Category	Coeff.	Z-Value
Reported Intention of Online Grocery Shopping After COVID-19 Is No Longer a Threat	Attitudes	Online Grocery Shopping Experience	0.31***	7.90
		Pro-Online Grocery Shopping	0.35***	6.90
		Pro-Driving	−0.11**	−2.46
	Education	Doctorate Degree	0.76***	4.25
		Professional Degree	0.68***	3.69
	Employment Status	Part-time	−0.24**	−2.50
		Unemployed	−0.36***	−4.49
	Household Composition	living with roommate only	−0.42***	−2.97
		living with significant other only (no kids)	−0.16*	−1.90
	Number of Non-working, Non-student Adults	1 to 3 Adults	0.20***	2.78
Pro-Online Grocery Shopping	Attitudes	Pro-technology	1.47***	6.59
		Pro-Telecommuting	−0.47***	−2.56

*, **, *** respectively denote significance at 0.1, 0.05, and 0.01 level.

The only two mediation effects observed in our model is the indirect effects associated with pro-technology and pro-telework attitudes. Accordingly, both effects are mediated through the pro-online grocery shopping. The pro-technology attitude has an indirect positive impact on the reported online grocery shopping intention after the pandemic, mediated by the pro-online grocery shopping. A similar finding was presented by previous studies (Park et al., 1996, Etminani-Ghasrodashti and Hamidi, 2020). The relationship between pro-telecommute attitude and online-shopping attitude is a bit complicated though, yet worth noticing. During their model training efforts, authors noticed that in the absence of pro-technology attitude, telework by itself increases online shopping. This positive correlation could stem from the root idea that welcoming new technology and adopting it as a replacement for conventional way of doing things can improve quality of life. Benefits such as avoiding the disutility of out-of-home travel and more flexible and efficient time management could be names as simple examples of such improvements. However, when tech-savviness is accounted for in the structural model, telework impacts turns into negative. In this regard, authors believe that telecommute impacts could be viewed in two separate directions: a technology aspect, and a travel behavior aspect. The technology aspect, which is in common with online shopping attitude, is likely to encourage online shopping; The second aspect, which is related to the relaxed spatial–temporal constraints (as opposed to regular commute to work), has a tendency to increase the chance of other out-of-home non-mandatory activities during the day (Asgari et al., 2016, Asgari and Jin, 2017), which may potentially counteract the first positive effect and increase the likelihood of in-store shopping. Therefore, when the pro-technology attitude is incorporated in the model, the rest of telecommute impacts turn out to address the negative effects of increased out-of-home activities (due to the relaxed constraints) on online behavior.

5.2.2. Socioeconomic and demographic attributes

In view of socioeconomic and demographic characteristics, results indicated that individuals with a high education level (i.e., a doctorate or a professional degree) are more likely to shop online for their groceries in the future. People with higher education levels probably are in the higher income brackets and might view the additional fees associated with online grocery shopping services as trivial. Also, people with higher education levels tend to spend more time searching for products online, which might encourage them to have a higher frequency of

online grocery shopping after the pandemic. This positive impact was expected as having a pleasant online grocery shopping experience can build individuals' trust and favorable perception, leading to more frequent use of these services. This finding is consistent with previous studies (Hansen, 2006; Min et al., 2012; Anschuetz, 1997). As expected, individuals with a pro-online grocery shopping attitude are more likely to shop groceries online after the COVID-19 pandemic. Similarly, the literature showed that perceived usefulness and easiness of online grocery shopping are the key factors that encourage the shift from in-store to online shopping of groceries (Driediger and Bhatiasevi, 2019; Bauerová and Klepek, 2018; Huang and Oppewal, 2006; Chakraborty 2019; Shukla and Sharma, 2018).

Interestingly, people who enjoy driving and the freedom associated with private vehicles are less inclined to do online grocery shopping after the pandemic. One potential explanation is that individuals with this attitude see driving as leisure, and they enjoy trips to the stores and being out of home for a change of environment. This attitude could strongly encourage people to make physical trips to grocery stores, which might affect their intentions for future online grocery shopping. This finding is consistent with the findings by Casas et al. (2001).

online grocery shopping (Etminani-Ghasrodashti and Hamidi, 2020; Zhen et al., 2018). Previous studies also showed that the value of time (VOT) might be higher for these individuals; therefore, online grocery shopping might be more attractive to them to save time for other activities (Punj, 2011, Van Droogenbroeck and Van Hove, 2017).

In terms of employment status, part-time and unemployed individuals are less likely to do online grocery shopping after the pandemic. Online grocery shopping is usually associated with higher unit costs as well as service and delivery fees, which might not be favorable for low-income individuals.

Our model shows that simple household structures (e.g., two roommates living together or a couple with no kids) are less likely to engage in online shopping. Smaller households usually buy lesser amounts of groceries, where the burden to shop and carry is negligible compared to larger households (Bawa and Ghosh, 1999). Moreover, a previous study showed that social interaction might be a strong motivation for people to choose in-store shopping over online grocery shopping. Van Droogenbroeck and Van Hove (2017) suggested that small sized households are more likely to view social interactions as incentives for favoring in-store shopping compared to larger households. Furthermore, with the presence of 1 to 3 adults, who are neither workers nor students, individuals are more likely to shop online for their groceries. This group might represent retired seniors. Online grocery shopping might be desired for seniors requiring mobility assistance because in-store shopping might be difficult and inconvenient (Morganosky and Cude, 2000).

6. Policy implications

Practically, one of the main outcomes of a consumer survey analysis is the market segmentation. Market segmentation is the process of dividing a broad range of consumers into sub-classes based on some type of shared characteristics. For instance, our study showed that employment, education, household composition, as well as personal attitudes can help classify current or potential online shoppers, with full time employees, individuals with higher educations, those coming from larger or more complicated households, tech savvy people, and individuals with prior experience to online shopping are more likely to be frequent online shoppers in the post pandemic condition. On the other hand, part-time workers, unemployed individuals, simple households consisting of roommates or couples without children, and pro driving individuals are less likely to favor online shopping. This simple inference can provide valuable insights to businesses on how to classify their target market, which will further help them in a variety of promotional activities such as advertising and marketing strategies. For instance, by detecting tech savvy people, they could be a rewarding target for online advertising methods such as social media platforms, while other groups such as people with lower education or senior families might respond more efficiently to conventional advertising methods such as TV commercials or flyers mailed to their door.

Market segmentation also results in a better understanding of the current and potential demand forecasting. For instance, disaggregate models like what was developed in this study could be further aggregated at a local neighborhood level. Clustering neighborhoods in view of their current/potential demand based on the residents' attributes will provide useful information to a variety of stakeholders. Business owners can use it to expand the size or the number of their stores or delivery hubs in certain areas. It also helps them identify underlying reasons in low demand neighborhoods and rethink incentive strategies such as discounts, free deliveries, or other well-defined amenities to attract latent markets in those neighborhoods.

From a transportation planning perspective, expansion of E commerce usually calls for a number of changes in urban logistics (Rutter et al., 2017). In particular, building warehouses and fulfillment centers should meet certain transportation related as well as urban planning standards. Warehouses are usually developed within or in proximity of urban areas and require access to interstate highways to accommodate

large trucks and other freight transportation facilities. Fulfillment and distribution centers are also expected to increase the inbound/outbound truck concentration in local roads that provide access to urban areas. Such frequent freight movements should be considered by MPOs and other local planning agencies when it comes to resource allocation in their plans. Local roads might need reconstruction or undergo rehabilitation programs to withstand the additional truck traffic. Increased maintenance activities and relevant costs should also be foreseen in the budget allocation. It is also important that location of such centers meets the required local and federal standards in relation to other adjacent land uses such as schools, residential areas, and other types of industrial and non-industrial uses. In addition, expansion of e commerce in the neighborhood with increase the number of relevant employees which in turn increases number of commute trips that not only increases peak hour traffic congestions but might also call for carpooling services to be considered in the area for those working similar shifts.

Groceries are also a good candidate for express or same-day delivery trips. Such deliveries are expected to increase non-peak traffic congestions in the local area. A recent study in Texas showed that many of the express deliveries are accomplished by non-commercial vehicles (Rutter et al., 2017). Such traffic is not usually accounted for in regional transportation planning models and might need to be implemented accordingly. In addition, certain types of standards and certification might be required for drivers and vehicles that deliver perishable goods.

From an urban planning standpoint, delivery vehicles require access to some type of drop-off or short-term parking. Such freight delivery needs should be discussed at municipality level. Lack of such amenities can result in increased congestion in denser local areas. In addition, when there is no requirement for face-to-face delivery, there should be additional storage space provided in multi-unit housings to allow package drop off in entry or common areas. This could be a new challenge for multi-family housing developers in dense areas with high demand for online shopping.

7. Summary and conclusion

As information and communication technologies continue to reshape human behavior and lifestyles in a variety of perspectives, there is a substantial need to foresee and plan for such technology-induced changes. In particular, the impacts of ICT on activity and travel related decisions of individuals has arisen the interest of researchers and planners. While a variety of different theories have been developed and tested in recent years, the pandemic experience provided a unique empirical opportunity for the researchers to observe and analyze how ICT adoption can substitute the normal way of doing things in practice, what the existing challenges are, and how different segments of a large population of people will react in response to new policies.

This study explicitly targets the concept of online shopping. While the literature suggests that online shopping behavior is strongly dependent on the type of goods being discussed, we narrow down our analysis to grocery shopping only. Data from an online survey conducted during the COVID 19 pandemic were analyzed for this study. The survey consists of information on socioeconomic and demographic attributes, online grocery shopping experience, as well as attitudinal questions about technology use, telecommuting, online grocery shopping, and driving. A structural equation model was applied to explore the impacts of the contributing factors on the reported online grocery shopping for delivery after the pandemic.

The descriptive analysis of the data showed a substantial increase in the frequency of online grocery shopping as well as the number of first-time online grocery shoppers during the pandemic. Besides, it was observed that the online grocery shopping frequencies before and during the pandemic are associated with the intention for using these services after the pandemic. In view of attitudinal questions, most respondents believed in the convenience of online grocery shopping; however, the mental effort required in choosing products from pictures on the web

pages might still present barriers for some shoppers.

The model results indicated that those who showed a higher frequency of online grocery shopping during the pandemic would also be more likely to shop more frequently for groceries online after the pandemic. This positive correlation might emphasize the positive role of prior experience or familiarity, where consumers with higher familiarity are more comfortable with the service and continue using it. Moreover, consistent with findings in the literature, positive attitudes toward online grocery shopping which stem from higher levels of efficiency, convenience, usefulness, and easiness would lead to more frequent online grocery shopping in the long term. On the other hand, those who enjoy driving or the freedom associated with private vehicles are less likely to adopt online grocery shopping for delivery after the pandemic. In view of the pro-telecommuting attitude, authors believe that extra attention should be paid. In general, and in the absence of tech-savviness information, the pro-telecommuting attitude has a positive correlation with online shopping attitude. This is mainly rooted in the common values that pro-technology people believe in, that ICT applications regardless of form, can improve the quality of life both at individual and society level (Shabanpour et al., 2018, Asgari et al., 2019). However, when tech-savviness is directly and separately addressed in the model (just as we see in our final model here), telework tends to moderate the positive technology-induced impact by exerting a negative effect, probably associated with the higher temporal/spatial freedom that allows a teleworker to pursue non-mandatory out-of-home activities, such as in-store shopping.

In terms of socioeconomic and demographic characteristics, the findings indicated that unemployed individuals or part time workers have a negative tendency toward online grocery shopping after the pandemic, probably associated with their income level or lifestyle preferences. On the other hand, full-time employed individuals, and those with higher levels of education are more likely to shop groceries online, which could be attributed to their higher income levels, familiarity with technologies, and higher value of time. As expected, larger households with more complicated structures are associated with a higher reported online grocery shopping intention after COVID-19 after the pandemic, perhaps because of higher demands for groceries and a lower need for social interaction.

COVID-19 has changed individuals' shopping behavior and habits, especially when it comes to shopping for groceries. While many online grocery shoppers could go back to traditional in-store shopping after the pandemic, some others might continue online grocery shopping. Although literature predicted that the pandemic has brought about fundamental changes in individuals' shopping behavior, and people probably will be more interested in online grocery shopping after the pandemic, they did not mention the attributes that increase the likelihood of future online grocery shopping. With a focus on attitudinal factors, this study fills this gap and explores the attributes that contribute to online grocery shopping after the pandemic.

This paper provides a valuable perspective on how to improve our ability to predict the potential changes in the pattern of online grocery shopping activities after the pandemic. The findings of this study suggest that people's grocery shopping behavior after the pandemic might be subject to change, at least based on their preference. In this regard, the results indicated that the number of people who shop their groceries online considerably increased during the pandemic. It was also found that people with a higher frequency of online grocery shopping during the pandemic are more likely to continue buying their groceries online in the future. This finding suggests that although there might be a decrease in the number of people who do online grocery shopping after the pandemic, the post-pandemic number is likely to be higher than that before the lock-down period. The switch to online grocery shopping is especially substantial for those with positive attitudes toward online grocery shopping as well as people with a technology-based lifestyle.

As evidenced by our experience throughout the COVID-19 pandemic, emerging trends toward the adoption of new technologies and services

have significant impacts on the transportation systems. However, the potential effects of these trends on travel demand cannot be reasonably predicted by conventional models that rely on demographic and socio-economic variables alone. In the future, agencies conducting regional household travel surveys can consider designing questions to collect respondents' attitudes toward technology adoption (e.g., online grocery shopping and other online services; electric and automated vehicles) and other emerging socioeconomic trends (e.g., lower birth rate). Exploring individuals' attitudes toward these trends offers additional information for modelers to build forecasting models that consider how attitudes intermediate between travelers' characteristics and their travel behavior.

This study is subject to a number limitations. Speaking of methodology, since the dependent variable (the reported intention of online grocery shopping expressed in five ordinal scales) reports the preferred (intended) frequency and therefore is more of a qualitative and relative nature, the results of the study cannot be interpreted as a prediction of future online grocery shopping frequency. Future studies based on quantitative dependent variables (e.g., revealed frequency of online grocery shopping) can be used to develop predictive models for online grocery shopping frequency. In addition, taking into account that estimating attitudes at personal level is not feasible, one might consider predicting them based on socio-economic and demographic attributes, which could be considered as a further enhancement of the model structure proposed in this study. One might also simultaneously model the pre and post pandemic frequency of online shopping frequency and test the causal relationship between the two. This may also help to compare the mechanism of the decisions in the two timelines and probably observe the evolution of attitudes during the pandemic condition. From a data perspective, it should be noted that not all respondents in our survey are employed or could telecommute, hence the impact of telecommuting on the dependent variable is subject to further scrutinization. Future studies can verify this with data from only employed individuals and/or those with telecommuting opportunities. In addition, because the dataset for this study is limited to South Florida, replication of this research with state- or national-level data can help verify and expand the findings of this study.

CRediT authorship contribution statement

Hamidreza Asgari: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Ghazaleh Azimi:** Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Ibukun Titiloye:** Investigation, Writing – original draft, Writing – review & editing. **Xia Jin:** Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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