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Analysis and modeling of changes in online shopping behavior due to Covid-19 pandemic: A Florida case study

Alireza Adibfar\textsuperscript{a}, Siddhartha Gulhare\textsuperscript{a}, Siva Srinivasan\textsuperscript{a}, Aaron Costin\textsuperscript{b,\ast}

\textsuperscript{a} Department of Civil and Coastal Engineering, University of Florida, United States
\textsuperscript{b} M.E. Rinker Sr, School of Construction Management, University of Florida, United States

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\section{ABSTRACT}

The emergence of eCommerce and online shopping commenced a new episode in human life and changed trading patterns. Online shopping provided access to a broader range of products and facilitated their delivery, which increased demand. To respond to the increased demand, more heavy commercial vehicles need to be on the roads to deliver orders. This is while the road infrastructure is not ready for such a swift shift, and most roads and bridges were planned and constructed during the 19s when online shopping was not coined yet. The continued increase of heavy vehicles on roads can intensify the deterioration of roads and structures such as bridges. Therefore, there is a significant need for an update on new shopping trends, especially changes in people’s behavior due to the ongoing Covid-19 pandemic, and to assess if the pandemic permanently changed the trends of in-store and online shopping. This study first examines the NHTS 2017 data to find the attributes that are significant to online shoppers’ behavior. Then a survey is developed to scrutinize Covid-19 effects on the online shopping behavior of users before, during, and after the Covid-19 pandemic. 206 records of data are interpreted through descriptive analysis and discrete choice modeling of users’ responses to find the most significant attributes affecting their online shopping behavior. The findings of discrete choice modeling and descriptive analysis support that people tend to go back to stores after the pandemic. The findings of this study show that online and in-store shopping would be balanced after the pandemic and would pursue their normal trends as they were before the pandemic. Based on the findings of this study, it is hard to state that online shopping can vanish in-store shopping due to Covid-19. People still need to go to stores to fulfill their needs for the joy of shopping, interactions with other people, and touching the products they would like to buy. Therefore, transportation stakeholders need to pay special attention to both in-store and online shopping for their planning and operation management of ground transportation infrastructure.

1. Introduction

Transportation networks have always been considered crucial elements in the development of countries by providing faster and more convenient ways for passenger and freight movement. Ground transportation is one of the most popular modes of transport among the available modes due to their lower cost and availability of required infrastructure (Costin et al., 2018). Commercial transportation is a popular medium for freight transportation, and the commercial fleet owns the lion’s share of road transportation traffic. After the advent of online shopping in the early 80s, the role of commercial vehicles became more conspicuous, and they have played an undeniable role in the development of the online shopping industry (The Economist, 2017; KIlcarr, 2013). However, there is a concern that the simplicity of online shopping leads to more online purchases, and more trucks should hit roads for their delivery, which will increase fuel consumption and air pollution (The Guardian, 2016).

After the 2000s and the emanation of online shopping platforms, the number of online transactions increased. In early 2020, after the emergence of the Covid-19 pandemic and due to the curfew orders and stay-at-home recommendations, the number of online transactions skyrocketed. At this time, social distancing was recognized as the most effective pro-active strategy for slowing down the spread of the disease, and people started to use online shopping for ordering their daily needs from home, even groceries. In March 2020 and at the beginning of the pandemic, most chain stores that were not providing grocery services

\ast Corresponding author.
E-mail address: aaron.costin@ufl.edu (A. Costin).

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were recognized as “nonessential” and ordered to be closed for an indefinite period. While 25,000 stores were closed immediately, it was predicted that 15,000 more retail stores might permanently close their doors in 2020, 60% more than the 2019 records (Del Ray 2020; Bhatтарai, 2020; Smithson, 2018; Whitman, 2020). Covid-19 continued to hit global industries hard and put some industries, including the travel and fashion industry in the red zone. The travel industry experienced an 81% plummet in their expected annual revenues for April and May 2020 after the emergence of Covid-19. The total impact was estimated to be around $1.2 trillion, while it also jeopardized nearly 50 million jobs in the United States (Jones 2020). On the other hand, the pandemic shed a green light on industries developed on an online foundation such as online shopping (i.e., Amazon) and entertainment (i.e., Netflix). During social distancing and stay-at-home orders, online shopping was the most used method for procurement of daily needs. Businesses such as Amazon and Walmart, which have had strong online shopping and delivery organization, experienced a significant increase in their online transactions. They had to hire more workers to respond to the new demand (Del Ray 2020). Before Covid-19, online shopping was forming 10–15% of overall retail in the United States, while Amazon had a significant share of it by 40%. In March 2020, Amazon consumers spent 35% more than the same period in the previous year to buy their essential items, making Amazon hire 175,000 more workers to respond to the new demand (Del Ray 2020; Dustin and Rana 2020). In response to the Covid-19 pandemic, commercial truck drivers received an extension for their cap of the maximum allowed working hours to be raised from 11 h per day to 14 hours per day for some essential items to respond to the increased demand during this time (Encinas 2020). The online retail sector is expected to raise $6.5 trillion by 2023 (Jones 2020).

At first glance, online shopping reduces the number of travels, saves energy, and reduces environmental hazards. It helps people with their needs by eliminating unnecessary urban trips, diminishing congestion, air, and noise pollution while supporting sustainability by reducing fuel consumption and air pollution. From another perspective, more commercial vehicles need to be on the road to deliver online orders, which undermines the pure benefits of the online shopping system.

Transportation planners constantly monitor, analyze, and model commuters’ travel behavior to ensure the reliability of roads and maintain a reliable traffic flow on the network. Smart city researchers constantly follow road users’ behavior changes to apply them to their developing guidelines for planning smart cities (Costin et al., 2019). Covid-19 was an unexpected phenomenon that made planning and forecasting more complex by changing patterns. Therefore, there is a need to update the information and keep the system up-to-date and proactive. This study aims to find out the changes in patterns for in-store and online shopping behavior of people that were caused due to the emergence of the Covid-19 pandemic. This research reviews previous studies on users’ behavior in the online shopping concept. Then, it analyzes the U.S. Department of Transportation, Federal Highway Administration (2017) National Household Travel Survey (NHTS) data to find out the user attributes (such as age, gender, etc.) that affect their shopping behavior and uses this information to establish a survey. After collecting data through a questionnaire, the data areanalyzed using ordered response models, and the results of the modeling process are discussed and concluded.

2. Literature review

Online shopping is one of the emerging technologies in the 21st century that require immense attention from planners. Online shopping has brought convenience to customers (Miyatake et al., 2016; Muller et al., 2019; Rifa et al., 2019; Suayanto et al., 2019), and vendors are continuously putting effort into improving the online shopping experience for their customers (Walmart, 2021; Duarte et al., 2018). Beau-champ and Ponder (2010) found that online shopping has helped customers make decisions and reduced their relative efforts. Customers can now browse different retail brands, compare prices, and get notified about every new product at their fingertips. Duarte et al. (2018) stated that finding similar products and comparing them instantly both in value and technical details, is a significant factor in customers’ satisfaction. As Fig. 1 shows, the online shopping market could sell nearly $300 billion in the United States in 2014 (Lee et al., 2017), reached $345 billion by the end of 2019, and is projected to hit $476 billion by 2024 (Statista 2020). However, this increase may negatively affect the deterioration of ground transportation infrastructure, specifically the aged bridges (Costin et al., 2018; Adibfar and Costin, 2019a,b).

Transportation planners, researchers, and research and development (R&D) teams in commercial companies constantly study user characteristics that affect online shopping expansion. Lee et al. (2017) studied the Davis, California area to find the effects of personal characteristics, attitudes, perceptions, and the built environment on customers and found that characteristics and perception have the highest impact on customer behavior. They also found that people who do in-store shopping more often, are the ones who do a considerable amount of online shopping. Dias et al. (2020) studied the user behavior in online and in-person shopping and eat-outs and evaluated the 2017 household travel data through a Probit model, and found that income, surrounding environment, and the structure of the household are attributes that have a significant effect on people’s behavior in online shopping. Several studies confirmed that age is the most significant attribute to online shopping behavior. A recent study by Warren (2019) for United Parcel Service (UPS) shows that people aged 25–34 and 35–44 have the highest online shopping frequency. Another study in Finland showed that older adults are becoming a more important segment in developing strategies for online shopping. Kuopamaki et al. (2017) initially reviewed literature and found that age, education, amount of access to technology, perception about online shopping benefits, and the people’s attitude and trust in online vendors have the most influence on people’s decision to use online shopping. Furtherly, Kuopamachi et al. (2017) focused on studying the use of mobile phones amongst people aged 55 to 74 for online shopping and found that people in this age group have behavior similar to young people for online shopping. While the smartphone and tablet ownership proportion is more prevalent in young people compared to older adults (90% for people between 16 and 44 compared to 63% for people between 55 and 64), older people have similar behavior and rate in online shopping. They found that as the age increases, mainly for ages between 70 and 74, the rate of online shopping decreases. People above 70 are less likely to have the required social networking and online shopping skills. Also, their income has a significant role in doing online shopping, and people who are at the age of retirement and their income level may be limited are less likely to do online shopping frequently. On the other hand, older people will have more time for in-store shopping after retirement. Kuopamaki et al. (2017) also investigated age and gender and found that younger people use mobile devices primarily for entertainment purposes. Comparing the gender of older adults, they found that both genders had similar characteristics in online shopping, but older women were less likely to use mobile devices for entertainment. The study found that households with children have a higher probability of doing online shopping. Also, education has a significant role in the online shopping of adults. Their study concluded that age, higher education, and type of household have the most significance in online shopping behavior. Thaichon (2017) studied the children’s behavior for online shopping in Australia and found that age, parental guidance, control, influence by friends, and social media have the most impact on children’s online shopping behavior.

According to National Household Travel Survey (NHTS) 2009 results, Santos et al. (2011) found that 20% of household trips and 15% of vehicles traveled miles were originated for shopping purposes. Suel and Polak (2017) evaluated the effects of online shopping on travel behavior changes and stated that the online shopping concept would make the travel forecasting procedure more complex. In the online shopping
concept, individual travels for shopping need to be converted to home deliveries through careers that utilize freight forecasting models. Another complexity is that sometimes a carrier will drop the package into a dropbox, and then the customer needs to make another trip to pick up their goods, which splits a delivery trip into two, and these problems will make the prediction more complex. Xi et al. (2020) also found that while at first glance, Same Day Delivery (SDD) has reduced the number of trips to local shops, it could not be a long-term solution for the reduction of the total number of personal vehicles on roads. Xi et al. (2020) furtherly noticed that same-day delivery might increase the number of delivery vehicles on the roads, which will exacerbate the traffic congestion problems. Furthermore, people who used to walk to nearby stores to buy their needs may now use the delivery system or split their bulk purchase into several smaller and separate purchases which adds a considerable portion of trips into the traffic compared to the normal situation. In some eastern countries where the delivery crews use motorcycles and scooters for delivery, the SDD may push the crew to break the traffic rules and intensify the traffic congestion and increase the number of accidents. Using pedestrian and bicycle lines, wrong-way movement, and not adhering to traffic priority rights may lead to crashes and congestion. Xi et al. (2020) reported that only in the first half of 2017, there were 3242 accidents in Nanjing-China that delivery vehicles and scooters were involved in Xi et al. (2020) stated that the increase in delivery vehicles would subsequently increase environmental pollution. Another study disputes the negative environmental effects of online shopping, which may have arisen from the difference in location and culture. Rosqvist and Hiselius (2016) studied the online shopping effect on transportation sustainability and carbon dioxide emission in Sweden and concluded that online shopping would help in reducing the Co2 emission that is generated through shopping trips by 22% in 2030 compared to emissions in 2012.

Schmid and Axhausen (2019) compared in-store and online shopping and found that people with previous online shopping experiences are more sensitive to prices as they are familiar with alternative channels and their prices. This category also showed higher interest in buying groceries online, as regular customers still prefer to have the pleasure and joy of in-store shopping. They found that this category of customers consists of younger people who are well-educated and more familiar with the technology. Lee et al. (2017) found similar results and stated that it is not likely that online shopping would be able to abolish in-store shopping. They found that while online shopping can help in price comparisons with enhanced convenience, people still prefer to do in-store shopping as it is more socially and emotionally fulfilling for customers and satisfies their shopping enjoyment. Several studies confirmed that despite all the pros and cons, the development of online shopping is inevitable and requires the governments’ proper planning. Rutter et al. (2017) evaluated the effects of the growth of e-commerce and online shopping systems on the ground transportation network and found that this growth is inevitable, and all the stakeholders such as legislators and governmental agencies, planning and engineering dep- uties, and freight couriers need to share the information and lean toward integration to ensure the safety, reliability, and mobility of this system. A more recent study by Jaller and Pahwa (2020) confirmed that the development of online shopping and urban freight system is an inevitable act to sustain the freight movement and guarantee on-time deliveries.

Recently, more studies have focused on evaluating the effects of the Covid-19 pandemic on traffic, online shopping, and behavioral changes. Tian et al. (2021) evaluated the congestion and air quality in big cities of Canada and found that congestion has been reduced, which caused an improvement in air quality. Sun et al. (2021) studied the effects of the Covid-19 pandemic on the reduction of air travel demand and suggested the utilization of unused large aircraft to respond to the increased online shopping demand. Cusack (2021) evaluated 213 people in Philadelphia-Pennsylvania through an online survey and found that there has been a significant decrease in the number of people walking or using bicycles for their commutes. In a similar study, Zhang and Fricker (2021) studied 12 trails in 11 locations in the United States and found that the number of people who were using trails for bicycling and walking has been significantly reduced. This shows that people are afraid of getting exposed to Covid-19 and prefer to spend their time at home, which increases the chance of online activities. Zhang et al. (2021) stated that the number of online advertisements by the consumer industry has been increased during the pandemic to absorb more sales from online orders. Shamshiripour et al. (2020) studied Chicago metropolitan area and found that during the pandemic, safety has a higher value for customers compared to the prices, and they may spend more money to keep themselves safe and healthy. They found that more than half of their study population have never had any online grocery shopping experience before. Their research also shows a significant increase in the number of people who do online shopping and order food online due to the pandemic. They found that habitual online shopping
for groceries is on the rise, which has a higher rate than food orders. They concluded that restrictive orders need to be accompanied by proper planning to bring back the expected efficacy of curfews and restrictions.

A few academic publications are available to the date of publication of this research that evaluated the effects of Covid-19 on people’s shopping behavior.

Shen et al. (2022) investigated the effects of Covid-19 on grocery shopping trends and found that fear of infection caused more people to purchase their groceries from online platforms during the pandemic, and a considerable portion of the respondents declared they would continue online grocery shopping even after the pandemic. They developed a survey, audited 310 people in Chicago, IL, and used a logit model to find significant attributes. Similar to the findings of the current study, they found Age, Income, and Household size to be significant to the online shopping behavior of families. Except for one attribute, the findings of Shen et al. (2022) are similar to the findings of the current study. They found that being female has a positive impact on online shopping, while the current research found that being male has a positive impact on the probability of online shopping. Grashuis et al. (2020) studied 900 people in the United States and evaluated their grocery shopping behavior changes due to the pandemic. Their findings showed that in areas with a decreasing infection rate of Covid-19, people are more interested in returning to stores and doing grocery shopping in person rather than using online delivery or pick-up services. They stated that even when the Covid cases were going rampant, people still stated their preference as doing in-store grocery shopping rather than online shopping. They found that the delivery time and minimum order requirements are the main reasons people prefer in-store grocery shopping. The findings of Grashuis et al. (2020) are similar to the findings of section 4.2.1 of the current study, where we found people still interested in doing in-store grocery shopping during and after the pandemic.

Koch et al. (2020) investigated the influence of different motives on the online shopping behavior of 451 German people and found that hedonic motivations have a higher influence on shoppers compared to utilitarian motivations. Utilitarian motives encourage people to perform an act due to the usefulness of behavior, while hedonic motives indicate that the joy and entertainment from doing a work is the primary driver of performing that act. The findings of this research are similar to the findings of current research as this research found that the joy of shopping and interaction with other people are significant motivators in bringing people back to stores. Shang et al. (2020) investigated the effects of Covid-19 on book shopping behavior of people in Vietnam and found that online shopping for books during the pandemic was more utilitarian. They also found that hedonic motives for online shopping for books to be positive but insignificant.

Erjavec and Manfreda (2022) studied the effects of Covid-19 on online shopping of senior people, aged 60 and older, and found that the influence of the social circle of elderly people has a direct impact on the frequency of their online shopping. They compared the effect of social media, and social circles, and found the latter to be more influential for elderly people. Kim et al. (2022) evaluated the impact of Covid-19 on online shopping and found that online shopping is causing 4.8 times more waste from packaging compared to brick-and-mortar shops and stated their concerns about the increased demand for online shopping after the pandemic and subsequent increases in waste.

3. Methodology

Authors initially used scholarly databases such as ScienceDirect and conducted a review of the literature on online shopping studies focused on examining user characteristics and behavior, specifically those that were scrutinizing users’ travel behavior, and then extended it to the literature relevant to Covid-19 and transportation planning issues. Their abstracts and conclusions were reviewed to find out the paper’s proximity to the current research needs and goals. Then the selected articles received a comprehensive review for the extraction of data and statistics.

After reviewing the literature, the authors used the 2017 National Household Travel Survey (NHTS 2017) data (U.S. Department of Transportation, Federal Highway Administration, 2017) to evaluate the behavior of online shopping users in Florida, United States of America. Each column in the NHTS online shopping data contained information about different attributes such as age or education level, and each row contained information about every individual responding to them. The tidyverse package (Wickham et al., 2019) in R was used to read, clean, analyze and prepare data for discrete choice modeling. Observations that reported Florida as their state were filtered and used for further analysis. The authors selected individual and household characteristics (based on descriptive analysis) to understand their impact on online shopping frequency. The rows which did not include all the relevant information of an individual were removed. Some of the variables, such as household income which were originally reported in the category (e.g., $50,000 to $74,999 per year) were transformed to the mean value of that category such as the average salary in each bin. Some individuals preferred not to report their household income, and their income was imputed with the median of reported household income i.e., $62,500.

There have been different answers about online shopping frequency during the past 30 days. While most of the respondents clearly answered this question, some people were not ascertained, did not know, or preferred not to answer this question. These records were removed from the database so the model can better evaluate online shopping behavior. The final dataset had 2383 observations with seven attributes. A further evaluation of the dataset showed only 5.2% of respondents had more than 10 online shopping attempts during the past 30 days. Analysis of the results shows that 40.5% of the respondent did not do any online shopping and 59.5% had at least one online shopping experience during the past 30 days.

The ordered response models have been extensively used to model ordinal responses such as frequency of trips, satisfaction levels, car ownership, etc. Therefore, the authors selected to use an ordered logit model, which recognizes the ordinal nature of online shopping frequency, to understand the attributes that impact the online shopping behaviors. The number of online purchases were converted into four ordinal categories and an ordered logit model (in R) was applied. The results of this section provided individual and household attributes that significantly impact online shopping behavior in a normal situation back in 2017.

After the first part, a questionnaire was developed to understand the impact of Covid-19 on shopping behavior. The significant attributes from the ordered logit model were embedded in the questionnaire to account for the heterogeneity among respondents. The questionnaire consisted of four parts. After a welcome note and acknowledgment of consent for continuing into the survey in the first part, in the second part, the user was asked to provide their demographic information such as gender, age, level of education, occupation, household income, household size, having elderly/children under 18 in the household, having any member with specific medical conditions, and total hours of internet usage per day. The participants were able to skip answering questions that they were not comfortable with. In parts three to five, participants were asked to provide information about the frequency of their online and in-store shopping in three different time periods as follows: February 2020: before the pandemic, September 2020: during the pandemic, and February 2021: after the hypothetical end of the pandemic. It should be noted that the survey was conducted in October 2020, in the middle of the pandemic, when the vaccination and other immunization media were not available yet. Covid-19 vaccines became available to the public starting in February 2021 (AJMC 2021). In each time sector, participants were asked to provide information about the frequency of their in-store, and online shopping under five categories of grocery, other household essentials (Toilet paper, cleaning supplies, etc.), electronics and computer technology, clothing and fashion items,
and finally books, music, and games. In part six, participants were asked to state their opinion about changes in the frequency of their online shopping, along with the reasons for any change in online shopping frequency.

The questionnaire was tailored to obtain before, during, and supposedly after Covid responses on both shopping medium and shopping types. However, due to the limited number of responses and its skewed nature, the responses were converted into binary categories: shopping and no shopping. The authors estimated ten binary logit models, one for each combination of shopping type (grocery, household essentials, electronics, clothing and books) and shopping medium (in-store and online). In order to understand the impact of Covid on shopping behavior, binary variables: ‘during Covid’ and ‘post Covid’ were included, while ‘pre-Covid’ served as the reference in the models. More detailed information about the modeling process has been provided in Section 4.1 and Section 4.3.

4. Results
4.1. NHTS 2017 data modeling

Federal Highway Administration (FHWA) conducts a travel survey every five to seven years to study the travel behavior of people living in the United States of America and uses those data to infer personal and household travel trends, and the latest publication is for the year 2017 (FHWA 2020). The NHTS 2017 data set (U.S. Department of Transportation, Federal Highway Administration, 2017) contains 264,234 records. After cleaning the data and limiting the location of respondents to the state of Florida, 2383 records were ready for modeling and analysis. Authors initially performed descriptive analysis on the sample, and the distributions of attributes could be reviewed in Fig. 2.

4.1.1. Data assembly

Each column in the NHTS online shopping data contained information about different attributes, and each row contained all information about individuals’ responses to those attributes. The tidyverse package (Wickham et al., 2019) in R was used to read, clean, analyze and prepare

![Fig. 2. Demographic information of NHTS 2017 data.](image-url)
data for discrete choice modeling. The data preparation process was briefly reviewed in Methodology. After the initial cleaning of the data, the frequency of online shopping was converted into ordinal categories, described in the next section. ‘Retired’ was the second most reported primary activity (nearly 40%) after ‘working’ and it is the most distinct category considering age, health, etc. Therefore, a new binary variable ‘retired’ was created based on the reported primary activity, where “1” stands for retired and “0” otherwise. The reported education had multiple levels, it was converted into a binary variable where, “1” stands for at least some college degree and “0” stands for high school graduate or lower.

4.1.2. Model structure

NHTS online shopping survey dataset reports the number of deliveries in the last 30 days. It is reasonable to assume that each delivery is equivalent to one instance of online shopping. The number of online purchases during the past 30 days was converted into four ordinal categories: (a) never (0 purchases in last 30 days), (b) sometimes (1–2 purchase in last 30 days), (c) weekly (3–5 purchase in last 30 days), and (d) frequently (more than 5 purchases in last 30 days). Ordered logit model which recognizes the ordinal nature of categories was used. The ordered logit model has been extensively used in transportation literature to model the frequencies of trips (Agyemang-Duah and Hall 1997), satisfaction levels (Bellizzi et al., 2018), number of cars (Potoglou and Sulsio 2008), etc.

The ordered logit model is based on the hypothesis that a latent continuous variable $T_n$ represents the frequency of online shopping propensity of user $n$. The latent propensity $T_n$ is a sum of deterministic component and an error term $e_n$ with logistic distribution. The deterministic component has linear specification and can be written as $\beta' X_n$, where $\beta$ is the vector of parameters (to be estimated) corresponding to exogenous variables $X_n$.

$$T_n = \beta' X_n + e_n$$

where the term $Y_n$ represents the reported frequency, $i$ represents the threshold bounds of the latent propensity, demarcating it into ordinal categories. The probability that user $n$ makes $j$ online shopping purchase is given by

$$P[Y_n = j] = \Phi(\lambda_j - \beta' X_n) - \Phi(\lambda_{j-1} - \beta' X_n)$$

4.1.3. Model estimation

Two group of variables were considered for analysis: (a) User characteristics and (b) Household characteristics. The variables which were believed to be relevant and relatively less correlated were selected. Age, household income and household size are continuous variable whereas, others are binary variables. An interaction variable ‘retired with ‘medical conditions’ was also introduced to understand the online shopping trends of retired with medical conditions, who are relatively captive to in-store shopping. The model estimation was performed using package MASS (Venables and Ripley, 2002) in R. The results of the ordered logit model of frequency of online shopping are provided in Table 1. The positive sign indicates that the increase in the attribute will increase the propensity to online shopping, while the negative sign indicates that the increase in attribute will decrease the propensity to online shopping.

Evaluation of user characteristics in estimated parameters suggests that the propensity for online purchase decreases with the increase of age, and is lower for males (relative to females, keeping all other characteristics the same). The former result is intuitive and consistent with other studies. The propensity increases for those who have some college degree, it may also be attributed to their increased level of household income and education. Individuals who are retired and have medical conditions were found to have a lower propensity to purchase online, however, these results are significant at only 90% confidence level.

### Table 1

| Variable                          | Parameters | t-stat |
|----------------------------------|------------|-------|
| Male                             | -0.23      | -3.02 |
| Age                              | -0.02      | -8.28 |
| College degree                   | 1.25       | 12.86 |
| Medical condition                | 0.33       | 1.16  |
| Retired with medical condition   | -0.61      | -1.84 |
| Household income (in thousands)  | 0.001      | 4.09  |
| Household size                   | -0.10      | -2.54 |
| Urban                            | 0.20       | 1.64  |
| Intercepts                       |            |       |
| never | sometimes | 0.60   | 2.47  |
| sometimes | weekly | 0.54   | 2.20  |
| weekly | frequently | 1.78  | 7.10  |

Significant at 95% confidence level.
Significant at 90% confidence level.

4.2. Analysis of Covid –19 questionnaire data

After analysis of NHTS modeling data, authors used the findings of the modeling process to develop a questionnaire and study the effects of Covid-19 on online shopping behavior changes during and hypothetically after the pandemic. The questionnaire was asking respondents to assume themselves in Scenario 1) February 2020 before the start of the pandemic, Scenario 2) in September 2020 during the pandemic (One month before the data collection), and Scenario 3) in February 2021 when the pandemic would be hypothetically over, and everything would be in the normal situation again. The data collection started on October 1st, 2020 and was concluded on October 31st, 2020. It should be noted that no vaccine was available at the time of the data collection process in October 2020. The survey was circulated as widely as possible. A total of 258 responses were collected. After cleaning out the incomplete responses, the total number of records were 206.

Authors processed the data for their analysis and modeling through descriptive analysis and discrete choice modeling. Initial analysis of data showed that the dataset is dominated by respondents in Florida who are mostly working or are university students. 46% of respondents were male, and 53% were female. Evaluation of the Age variable shows 51% of respondents were between the ages of 20–29 years old, and nearly 27% of them were between 30 and 39 years old which means more than half of the respondents were active groups of society. 4% of respondents were between 17 and 20 years old and could make online shopping by themselves independently, and 18% of respondents were between 40 and 70 years old.

Evaluation of income and household size (HHSIZE) showed that 27% responded their household size as one person. Further analysis and
comparison of this group along with the age distribution variable showed that nearly 45% of the respondents were students and might be still single. 30% of respondents stated they have two people in their households, and nearly 43% of respondents had 3 and more people in their household. 84% of respondents did not have children in their household, and nearly 87% of them did not have a person over 65 years old as an elderly member in their household. Nearly 78% of respondents did not have any person with special medical conditions in their households. Evaluation of the education level of respondents shows that 5% of them had a high school degree and lower, 23% had some college or associate degree, 26% had a bachelor’s degree, and 46% had a graduate or professional degree. This result could be predictable as most of the respondents were from academic institutions or were people who had a professional degree and were working in the industry. The questionnaire also asked for the average time that respondents spent daily browsing the internet for different purposes. The average spent time was reported to be 3.24 h per day with a median of 3 h. It could also be derived from the collected data that the respondents mostly spent between 1 and 5 hours a day browsing internet for different purposes. With only 3 people responding they spend less than an hour browsing the

Fig. 3. Demographic information of survey respondents.
After finding out about the demographics of respondents, authors developed comparative charts based on the responses they received through the questionnaire to be able to compare behaviors at different times and find out possible trends. The results of this analysis could be reviewed in Fig. 4.

4.2.1. Grocery shopping

Based on the findings of Fig. 4, evaluation of the shopping trend for grocery shopping shows that people’s behavior has not been significantly changed during the pandemic and most people did their weekly shopping in-store. Most people never used online shopping before the pandemic, but there was a slight change after the emergence of the pandemic, and people started to do online grocery shopping as well. While some people stated that they will continue using online services for their grocery shopping, most people still prefer to go back to stores to do their grocery shopping.

4.2.2. Household essentials

Evaluation of the results shows that most of the respondents almost never used online shopping services for buying household essentials such as detergents, tissues, and other products before the pandemic. Answers to this question is similar to grocery shopping behavior. As most of the household essential items are available in grocery stores, it could be derived that people used to buy their household essentials along with their groceries in stores. After the emergence of the pandemic, some household essentials such as disinfectants, paper towels, and toilet paper became unavailable in stores, and people switched to online platforms to order these products. As illustrated in Fig. 4, the number of people who stated that they will never use online services for buying household essentials after the pandemic is reduced, and subsequently, the number of occasional and weekly online purchases during and after the pandemic is increased and sustained. It could be derived that while a considerable portion of respondents did not try online shopping for buying their household essentials before the pandemic, the small portion that switched to this system liked that and would continue using this service. It could be concluded that the demand for using online services for buying household essentials will have a slight increase.

4.2.3. Electronics and computers

Initial assessment of responses to the question about changes in shopping for electronics shows that people are not buying electronics on a weekly or more frequent basis which seems to be normal as people do not attend stores or use online services as frequent as they do for grocery or essential household items shopping. People often buy new electronics every year or, every couple of months. Comparison of results shows that people were using an even portion of online and in-store shopping for procurement of their electronics needs before the pandemic. During the pandemic, as many stores were closed or offering curb-side pick-ups only, people were using online services more, and after the pandemic they would use online shopping more which may be arisen from their good experience with online services received. Review of the findings in the literature review shows that as people can find a significant amount of information online, can compare products, use promotions, tailor the search criteria to their budget and need, and read others’ opinions about their experience, they mostly prefer to use online services for electronics shopping. While nearly 20% of respondents preferred to go back to stores to buy their electronics, more than 60% of respondents stated that they would use online shopping services more for procurement of their electronics after the pandemic would be over. The reason for those who are going back to stores for buying their electronics could be that they can compare products visually, touch them, and feel them by having them in their hands, and check their comfort and satisfaction with products. They can also test different products such as phones, head-phones, and speakers and compare their qualities. Altogether, this could be concluded that electronics will have a significant role in online shopping markets in the future.

4.2.4. Clothing and fashion items

Evaluation and comparison of online and in-store shopping behavior of respondents for buying clothes show that before Covid-19, people were in an equilibrium of online and in-store shopping, while in-store shopping was more attractive for people. By the start of the pandemic, so many stores were forced to temporarily close their doors for months, and some others went into liquidation and permanent shutdowns. Those who opened their doors after months reduced their in-stock items, and people were limited to the available stock, while the companies were offering online deliveries for a wider range of products. Moreover, so many clothing stores prohibited the use of fitting rooms due to the small space and frequency of use that could potentially lead to the spread of Covid-19. As a result, people started to use online shopping services to have access to a wider selection of clothing options. As Fig. 4 shows, people would do a combination of online and in-store cloth shopping after the pandemic. Comparing before and after the pandemic, it could be derived that people will use online shopping more for buying their clothing. There could be some reasons behind this increase. People who have rarely used online clothing services have experienced the ease of online shopping. The other reason would be that people may be more familiar with other websites that offer clothing, use discounts, and coupons could compare their prices, could benefit from the free and fast deliveries, as well as hassle-free returns. The results of the clothing shopping trend are similar to electronics and books. The most probable reason could be that people need to try on, touch, and feel clothing products to help with their decision-making and purchase.

4.2.5. Books and entertainment

Evaluation of the shopping behavior of people for buying books and entertainment media shows that people do not buy books and entertainment media on a weekly or earlier. Comparing the responses before and after the pandemic shows that before the pandemic, people used online services more for buying books or other entertainment, and even nearly 60% of respondents declared that they never went to a store in the past 30 days for buying books and used online services instead. Most of the respondents never went to a store during the pandemic and used online services instead. Based on the responses, it could be predicted that more than 20% of respondents will go back to stores to buy their books and entertainment, and there will be a slight increase in the number of online transactions for buying books and other media. The reason for people going back to stores could be similarly the joy of shopping and being able to touch the products or read through the books before buying them, which confirms that the joy of shopping is still a critical issue that will bring customers back to stores. Altogether, it is hard to predict that online shopping can vanish in-store shopping. People still need to go to stores to fulfill their needs for the joy of shopping and interactions with other people.

4.3. Covid-19 data modeling

After performing a descriptive analysis of data, authors used the discrete choice modeling method to determine the attributes that impact respondents’ online shopping behavior after the hypothetical end of the Covid-19 pandemic. Binary logit model was applied to understand shopping behavior and the impact of Covid for each combination of shopping medium and shopping type.

4.3.1. Data assembly

The participants of the online survey were asked to report their online and in-store shopping frequency before, during, and supposedly
Fig. 4. Side by side analysis of online vs in-store shopping behavior changes before, during and after Covid-19 pandemic in the sampled population.
after Covid based on predefined categories: (a) Never (b) Once/twice a month (c) Weekly (d) More frequently. However, due to the limited number of responses and its skewed nature, the responses were converted into binary categories a) “no shopping” corresponding to ‘never’ in the original survey, was assigned a value of 0, and b) “shopping” corresponds to remaining three responses, was assigned a value 1. Each row of data contained information related to an individual’s response and each column contained information about individual and household characteristics and the period considered for response (pre, during or post-Covid). Therefore, there were three rows corresponding to each respondent, one for each period. The period considered for the response was converted into dummy variables: (a) pre-Covid (b) during Covid and (c) post-Covid. The ‘pre-Covid’ variable was used as a reference and the other two dummy variables were employed in models: to understand the impact of ‘during Covid’ and ‘post Covid’ period relative to the ‘pre-Covid’ period. Other control variables such as user and household characteristics which were found significant on the NHTS dataset or were assumed to be relevant to the current study were added to account for the heterogeneity. Some of the variables in the online survey data were transformed e.g., household income and age were reported as categories (e.g., $50,000 to $74,999 per year, 30-39 years), and were converted to the mean value of that category bin. The education variable had multiple levels, which was converted into a binary variable, where 1 stands for at least some college degree and 0 stands for high school graduate or lower. As Covid is highly transmissible and severely affects those with existing medical conditions, a variable “medical condition” which was significant in NHTS data was included in the online survey. “Medical conditions” is also a binary variable, where 1 stand for any household member with medical condition and 0 otherwise.

4.3.2. Model structure

Binary logit model is based on the principle of utility maximization, which hypothesizes that an individual selects from the two choices to maximize his/her utility represented as which hypothesizes that an individual selects from the two choices to maximize his/her utility represented as which stands for at least some college degree and 0 stands for high school graduate or lower. As Covid is highly transmissible and severely affects

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P_j[j] = \sum\frac{e^{\beta_j X_{ij}}}{\sum e^{\beta_j X_{ij}}}\]

The probability of choosing alternative j is given by equation –

4.3.3. Model estimation

The questionnaire comprised of five shopping types: (a) Grocery, (b) Household essentials, (c) Electronics, (d) Clothing, and (e) Books; and two shopping mediums: (a) In-store and (b) Online. A separated binary logit was estimated for each of ten categories using package Apollo (Hess and Palma, 2019) in R. The estimates of models are shown in Table 2 and Table 3.

4.3.3.1. In-store shopping modeling results.

For in-store shopping, the parameter for ‘during Covid’ was found to be negative and significant for three shopping types: clothing, books, and electronics, which indicates that ‘during Covid’ period had negatively impacted the shopping propensity (relative to ‘pre Covid’ period) of these items. However, the impact of ‘during Covid’ period was found to be insignificant for shopping types – grocery and household essentials. It can be deduced that ‘during Covid’ period have caused a decline in the in-store shopping of non-essential items: clothing, books and electronics but it did not have an impact on shopping of essential items: groceries and household essentials. The parameters of ‘post Covid’ was found to be insignificant for all shopping type but grocery. The parameter is positive and significant for grocery which suggests that the in-store shopping tendency would be higher ‘post Covid’ (relative to ‘pre Covid’ period). The insignificance or positive significance of ‘post Covid’ parameter (in case of grocery) implies that in-store shopping behavior will return to normal supposedly post Covid, such behavior can be attributed to factors such as optimism among respondents to return to supermarkets after pandemic. Most of the individual and household variables were found to be insignificant. For shopping type - electronics: male and more household members have positive impact on in-store shopping. For shopping type - books: household size has positive significant impact. While age and medical condition have significant negative impact on in-store medium of shopping for books. There can be few reasons for that such as their limited accessibility to stores.

4.3.3.2. Online shopping modeling results.

The parameters of ‘during Covid’ was found to be significant and positive for two shopping types - grocery and household essentials which suggests that during Covid the tendency for online shopping was higher for grocery and household essentials relative to ‘pre-Covid’ period. This suggests that many participants started to purchase grocery and household essentials online more often during Covid. The parameters of ‘during Covid’ were found to be insignificant for non-essential shopping types: electronics, clothing and books, which implies that Covid has not impacted online shopping of these categories. The parameters of ‘post-Covid’ is also found to be significant and positive for shopping type – grocery and household essential, which suggests that the online shopping tendency for grocery

| Variables | Grocery Estimate | t-stat | Household essentials Estimate | t-stat | Electronics Estimate | t-stat | Clothing Estimate | t-stat | Books Estimate | t-stat |
|-----------|-----------------|-------|-------------------------------|-------|----------------------|-------|------------------|-------|----------------|-------|
| ASC shopping | 2.40 | 2.86 | 2.08 | 2.62 |
| ASC no shopping | 0.00 | NA | 0.00 | NA |
| during Covid | 0.42 | 1.28 | 0.20 | 0.63 |
| post Covid | 0.77 | 2.16* | 0.31 | 0.96 |
| Male | -0.37 | -1.24 | -0.23 | -0.83 |
| Age | -0.01 | -1.11 | -0.01 | -0.60 |
| College degree | 0.02 | 0.04 | 0.27 | 0.52 |
| Medical condition | -0.38 | -1.10 | -0.24 | -0.72 |
| Average internet hours | 0.11 | 1.33 | 0.00 | 0.03 |
| Household income | 0.00 | 0.61 | 0.00 | 0.52 |
| Household size | -0.09 | -0.80 | -0.02 | -0.17 |
| Likelihood at equal shares | -428.4 | -428.4 | -428.4 | -428.4 |
| Likelihood at convergence | -184.3 | -206.3 | -408.8 | -358.8 |

* Significant at 95% confidence level.
* Significant at 90% confidence level.

Table 2

Estimates of binary logit for in-store shopping.
and household essentials might have changed permanently relative to ‘pre-Covid’ period. The parameters of ‘post-Covid’ were found to be insignificant for non-essential shopping types: electronics, clothing, and books, which implies that online shopping tendency will continue to remain the same as pre-Covid. Most of the individual and household variables were found to be insignificant. Household income is significant and positive for all three non-essential shopping types: electronics, clothing, and books, which is consistent with intuition and existing literature that online shopping tendency for non-essential items increases with increasing household income. This is also in line with our findings in the analysis of the NHTS data. The results of the modeling could be reviewed in Table 2.

The modeling and analysis of online shopping data show that the parameter for Male is positive and significant for both online and in-store shopping of electronics items which suggests that Male (relative to female) were more likely to purchase electronics. The parameter for a medical condition is also negative and significant for online shopping of groceries, which suggests that if a household member has a medical condition, the members are less likely to purchase to online shopping. This result was counter-intuitive, one of the possible reasons could be that there were not enough respondents with elderly people in their families, and also these elderly people might have been less comfortable with online shopping. The parameter of non-essential items: electronics, clothing, and books is positive and significant for household income which reflects the increasing purchasing power with an increase in household income. The parameter for household size is significant for online grocery shopping which suggests that households with more members are more likely to purchase groceries online than lesser members. One of the possible reasons could be free delivery or low delivery charges per unit purchase, the larger household size is likely to purchase more groceries which makes them eligible for free delivery or reduces the delivery charges per unit of purchase.

### 4.4. Post-pandemic analysis

In the first quarter of 2022, the number of new Covid cases was significantly decreased, most of the Covid-19 restrictions were lifted, and people could return to stores and shop without any restrictions. As the main goal of this research was to predict users’ behavior and changes in online shopping, the authors performed an updated review of the literature and analysis of updated data to compare the findings of this study with real-world data and trends in 2022. The results of this analysis confirm and validate the predictions made in the previous section of this research.

Recently, the U.S. Department of Commerce (2022) released an e-commerce report. They compared the quarterly online and in-store retail sales and found that by the end of the year 2021, people did more in-store shopping than online shopping. A comparison of the fourth quarter of 2020 retail sales with the fourth quarter of 2021 shows that the share of e-commerce dropped from 13.6% to 12.9% from all sales trade.

eMarketer is a research company that provides analysis related to e-commerce and digital marketing trends. eMarketer (2022) performed an analysis, and as shown in Fig. 5, found that while e-Commerce retail experienced a hike during 2020, online sales went back to their normal trend in 2021 and 2022, and it is projected to continue having a normal ascending trend.

Authors reviewed the quarterly and annual reports of online shopping leaders, specifically Amazon, and analyzed the year-on-year net sales which revealed similar results. For Amazon (Amazon 2021a; 2021b), while the amount of year-on-year net sales leaped in 2020, this rate has been decreased after the pandemic and is coming back to its normal ascending trend as shown in Fig. 6. While there is no doubt that online shopping has an increasing trend, one argument could be that while the amount of total net sales has been increased, the number of sold items might not have been equally boosted (See Fig. 7). According to the U.S. Bureau of labor statistics (2022), the average rate of consumer prices has been increased by an average of 7.5 percent by the end of January 2022. The authors did not have access to such data to investigate the number of transactions to verify this hypothesis.

Brooks (2021) recently analyzed the results of a survey conducted on more than 19,000 people worldwide and found that people still prefer to do their shopping in-store instead of online. Trying products in-store,
supporting local businesses, and avoiding delivery delays and fees were some of the reasons that people selected in-store shopping over online shopping. This study showed that less than ten percent of respondents do online shopping on a weekly basis. Most of the respondents stated that they used their mobile and tablets to do research, check prices, and find the best deals, but most of them returned to stores for finalizing their purchases. Security and credit card data breaches were of the main reasons people are still hesitant to fully adopt online shopping in their lifestyle.

PWC (2022) audited over 9000 people in December 2021 and revealed that the rate of in-store shopping is increasing, and it is mostly recovered to the pre-pandemic. More than half of the respondents mentioned they would like to do local shopping, most preferably within a one-stop trip, and they noted convenience as their main motivation.

However, the results of their study show that people are now using a more balanced share of in-store and online shopping while 47% do in-store shopping on a daily/weekly basis, and 41% use their smartphones for their online shopping. PWC also confirmed that data privacy is one of the main concerns of online shoppers.

Data from Statistica shows that while there was a spike in 2020 for online grocery purchases, the trend is coming back to normal and is projected to have a slight and normal increase through a five-year look ahead (Statistica 2022).

5. Discussion

The analysis of the results showed that the internet is now an integral part of human life. Respondents of this study spent an average of 3.24
hours per day browsing the internet for various purposes. This means that online services and platforms are becoming more popular and engaging, and people are spending a considerable amount of their time every day browsing the internet. This finding could be useful for all industries to focus more on online advertisement rather than paper-based advertisements as it would be viewed by more people compared to traditional advertisement strategies. Since people are spending a considerable amount of their time browsing online content, different industries may need to produce more online content to stay in competition with other companies and trades. Mastery in web programming and the development of professional online content could be deemed as one of the jobs that would be in higher demand in the future. Governmental agencies such as the United States Department of Health and other health administrations in other countries can invest more in relaying their information and educational content over online platforms as it would be accessed by more people.

The analysis of results showed that while Covid-19 caused some increases in online shopping trends, it did not drastically change its normal trend. Respondents' answers to a self-declaration question in the survey also yielded similar results which confirms this statement. In the last part of the survey, respondents were asked to express their opinion about their online shopping behavior after the pandemic. 59% of respondents stated that they will do more online shopping after the pandemic, 38% stated that their online shopping behavior would not be changed due to the pandemic, and only 3% stated that they would do less online shopping after the pandemic. People still desire to do in-store shopping, along with online shopping, unless an uncontrolled element decreases in online shopping trends, but it did not drastically change its normal trend. Respondents' answers to a self-declaration question in the survey also yielded similar results which confirms this statement. In the last part of the survey, respondents were asked to express their opinion about their online shopping behavior after the pandemic. 59% of respondents stated that they will do more online shopping after the pandemic, 38% stated that their online shopping behavior would not be changed due to the pandemic, and only 3% stated that they would do less online shopping after the pandemic. People still desire to do in-store shopping, along with online shopping, unless an uncontrolled element decreases in online shopping trends, but it did not drastically change its normal trend.

Number of online grocery purchases in the United States (Statista 2022).

Based on the findings of this study, using online shopping services for the procurement of grocery items and household essentials would continue to have an ascending trend. This finding highlights the fact that people who used online services for their household and grocery shopping during the pandemic found it to be a simple, fast, and attractive experience and stated that they will continue using it. This suggests that enhancement of platforms and equipping them with new features, ideas, and promotions can attract more customers and increase the rate of online shopping in this category. Findings show that the trend would be descending for other items such as electronics, clothing and fashion items, and books and their utilization would not be the same during the pandemic. The need for touching and feeling the products, trying them on and evaluating their appearance, being able to receive other people’s opinions, and most importantly satisfying the need for socialization and fulfillment of joy of shopping will still bring people to stores after the pandemic. Evaluation of electronics shopping showed that people would do more online shopping after the pandemic, but a considerable portion of them would go back to stores to evaluate and buy their electronics. The reason for those who are going back to store for buying their electronics could be that they can compare products visually, touch them, and have them in their hands to see if they are comfortable or satisfied with the products or not. They can also test different products such as cell phones, headphones, and speakers and compare their qualities, while this option is not available online. A comparison of clothing and electronics with grocery and essential household items shopping suggests that people would still prefer in-store shopping and would return to stores after the pandemic. It could be predicted that a considerable portion of respondents will go back to store to buy their books and entertainment. The joy of shopping and being able to touch the books and media or read through the books before buying them is still a critical need that will bring customers back to bookstores. However, as described in previous parts, the collected survey data are dominated by younger adults who are living in Florida, and the results cannot be generalized to the population as a whole.

During the pandemic so many stores reduced their in-store stock and laid off personnel, where so many people relied on receiving federal aid to spend their lives. This was a vague situation whether this situation will be temporary, or if stores and their employees need to find other ways to survive. The result of this study suggests that while planning on the improvement of online shopping platforms, mainly for grocery and household essential items would be a good investment, people still need to receive services in stores. Therefore, stores and trademarks need to
plan for a balanced investment for online and in-store improvements.

The pandemic caused a disruption in transportation, logistics, and delivery of goods. One of the main reasons was a reduction in the capacity and personnel in transportation hubs such as ports and customs worldwide. In the beginning, personnel were obligated to work from home which reduced the manpower at these facilities. Later, infection of personnel with Covid was the reason for these facilities to experience a lack of personnel to respond to the demand that was even increased after the pandemic. This shows that the transportation system is still considerably relying on manpower and is not automated enough to be protected against such phenomena. This is a problem that needs to be considered in long-term planning and strategies, and more studies need to be conducted on the automation of freight transportation systems. One of the reasons that trademarks such as Amazon could withstand and the pandemic. This shows that the transportation system is still protecting against such phenomena. This is a problem that needs to be considered in long-term planning and strategies, and more studies need to be conducted on the automation of freight transportation systems. One of the reasons that trademarks such as Amazon could withstand and the pandemic. This shows that the transportation system is still protecting against such phenomena. This is a problem that needs to be considered in long-term planning and strategies, and more studies need to be conducted on the automation of freight transportation systems.

Finding methodologies for the improvement of logistics and transportation at freight hubs and customs could be an attractive subject for transportation planners and students who would like to address practical issues during their studies. The use of Artificial Intelligence (AI) and Machine Learning (ML) in predictions and dynamic responses to the freight transportation problem could significantly help the freight transportation industry and governments.

Modeling of the collected data showed that Covid-19 negatively impacted the in-store shopping of electronics, clothing, and book items, while its impact on buying grocery and household essentials in stores were found to be insignificant. Comparison of pre and post-Covid data suggests that the tendency for online grocery shopping could be higher post-pandemic. This research initially predicted that although Covid-19 had a significant impact on the dramatic increase of online shopping trends, this would not be permanent, and online and in-store shopping would get into a balance again after the pandemic. Analysis of post-pandemic data confirmed this assumption and showed that Covid-19 has not permanently changed the online and in-store shopping trends. One of the possible inferences could be that the primary needs of human beings, such as the need for socializing or the joy of life, could not be ignored in the deployment of technologies. This conclusion can raise questions about the deployment of the fully automated eutopia that human beings have been dreaming about.

6. Conclusion

The main purpose of this research is to study trends of online shopping before and after the Covid-19 pandemic and investigate the change of patterns in online and in-store shopping behaviors. This research initially used NHTS 2017 data to understand the attributes of individuals that have a significant relation to their online shopping behavior. Then based on the findings, a survey was developed which received 206 valid responses. The results of behavioral modeling revealed that gender (being male), age, college degree, household income, and household size are significant to online shopping behavior at 95% confidence. It should be noted that the number and distribution of the responses were within the limitations of this study, therefore, it suggests that based on the collected data, the findings are more reflective of younger adults’ behavior, living in Florida, and is not a representative of the entire United States.

Store closures and employees dismissal from their jobs were some of the crucial concerns at the beginning of the pandemic. The result of this study suggests that although planning on the improvement of online shopping platforms would be a good investment, people still need to receive services in stores. Therefore, stores and commercial trademarks should plan for a balanced investment for online and in-store improvements. On the other hand, transportation and logistics heavily suffered from the pandemic where infection of trained personnel was one of the reasons. This shows that the transportation system is still heavily reliant on manpower and is not automated enough to be protected against such phenomena.

The result of this research showed that while Covid-19 had a significant impact on improving the attractiveness of online shopping, people still prefer to go back to stores for buying the items that need to be touched or visually evaluated. Authors predicted that Covid-19 would have a temporary effect on online shopping growth rate, and trends would return to their normal pattern and be balanced with in-store shopping after the pandemic. The findings highlighted those basic human needs, such as the need for socializing or enjoying interactions while shopping, are still critical factors that could not be ignored in development of technologies. This finding further raised a question whether deployment of a fully automated eutopia would be possible in the future, and if people would adopt that. Future research will concentrate on other granular online shopping attributes, such as delivery time, and analysis of changes in the online shopping behavior of people.

References

Adibfar, A., Costin, A., 2019a. Next generation of transportation infrastructure management: fusion of intelligent transportation systems (ITS) and bridge information modeling (BrIM). Adv. Inf. Comput. Civ. Construct. Eng. 43–50.

Adibfar, A., Costin, A., 2019b. Evaluation of IFC for the Augmentation of Intelligent Transportation Systems (ITS) into Bridge Information Models (BrIM). In: Proceedings of ASCiE international conference on computing in civil engineering, June 17-19, 2019, Atlanta, Georgia.

Agyemang-Asah, K., Hall, F.L., 1997. Spatial transferability of an ordered response model of trip generation. Transport. Res. Pol. Pract. 31 (5), 389–402.

AJMC, 2021. “A timeline of Covid-19 vaccine development in 2021”, https://www.ajmc. com/view/a-timeline-of-covid-19-vaccine-developments-in-2021 (August 15, 2021).

Amazon, 2021a. Amazon.com announces fourth quarter results”, https://ir.aboutamazon.com/annual-reports-proxies-and-shareholder-letters/default.aspx.

Amazon, 2021b. “Amazon Annual Report”, https://ir.aboutamazon.com/annual-reports-p roxies-and-shareholder-letters/default.aspx <https://ir.aboutamazon.com/annual-reports-proxies-and-shareholder-letters/default.aspx>.

Beauchamp, M.B., Ponder, N., 2010. Perception of retail convenience for in-store and online shoppers. Market. Manag. J. 20 (1), 49–56.

Bellizi, M.G., Eboli, L., Forciniti, C., Mazzulla, G., 2018. Air transport passengers’ satisfaction: an ordered logit model. Transport. Res. Procedia 33, 147–154.

Bhattarai, A., 2020. J.C. Penney Files for Bankruptcy plans to close some stores”, The Washington Post. https://www.washingtonpost.com/business/2020/05/15/jc-penny-bankruptcy-chapter-11. (Visited on July 17, 2020).

Brooks, Chad, 2021. Shoppers still prefer in-store over online shopping. Bus. News Daily. https://www.businesseventh.com/7756-online-shopping-preferences.html.

Costin, A., Adibfar, A., Hu, H., Chen, S., 2018. Building Information Modeling (BIM) for transportation infrastructure – literature review, applications, challenges, and recommendations. Auton. Conf. Struct. 94, 257–281.

Costin, A., Adibfar, A., Nawari, N., Eastman, C.M., 2019. Preliminary evaluation of the industry foundation classes (IFC) to enable smart city applications. Proc. CIB World Build. Congr. 398–407.

Cusack, M., 2021. Individual, social, and environmental factors associated with active transportation commuting during the COVID-19 pandemic. J. Transport Health 22, 101109. Elsevier.

Del Ray, J., 2020. Amazon Was Already Powerful. The Coronavirus Pandemic Cleared the Way to Dominance. https://www.vox.com/record/2020/4/10/21215953/amazon-fresh-walmart-grocery-delivery-coronavirus-retail-store-closures. (Accessed 27 April 2020).

Dias, F., Lavierei, P., Sharda, S., Kheini, S., Bhat, C., Pendyala, R., Pinjari, A., Ramadurai, G., Srinivasan, K., 2020. A comparison of online and in-person activity engagement: the case of shopping an eating meals. Transport. Res. Part C 114, 643-656.

Duarte, P., Costa e Silva, S., Ferreira, M., 2018. How convenient is it? Delivering online shopping convenience to enhance customer satisfaction and encourage e-WOM. J. Retailing Consum. Serv. 44, 161–169.

Dustin, J., Rana, A., 2020. Amazon Sees Possible Second-Quarter Loss as it Forecasts $4 Billion in Covid-19-Related Costs. Reuters. https://www.reuters.com/article/10/21215953/amazon-fresh-walmart-grocery-delivery-coronavirus-retail-store-closures. (Accessed 27 April 2020).

Encina, M., 2020. How to Prepare Your Fleet and Stay Organized during the Covid-19 Crisis?”. Material Handling & Logistics (MHL) News. https://www.mlnews.com/ covid19/2020/11/21218695/how-to-prepare-your-fleet-and-stay-organized-during-th e-covid19-crisis. (Accessed 27 April 2020).

Ehrmanz, J., Manfreda, A., 2022. Online shopping adoption during COVID-19 and social isolation: Extending the UTAUT model with herd behavior. J. Retailing Consum. Serv. 65. https://doi.org/10.1016/j.jretconser.2021.102867. (Accessed 12 September 2020).

FIHA, 2020. National Household Travel Survey”. https://nhts.ornl.gov. (Accessed 12 September 2020).
Guardian, 2016. How Green Is Online Shopping?. https://www.theguardian.com/environment/2016/feb/17/how-green-is-online-shopping. (Accessed 27 April 2020).

Grubhuis, J., Skevas, T., Segovia, M., 2020. Grocery shopping preference during the covid-19 pandemic. Sustainability, 12, 5369. https://doi.org/10.3390/su12135369.

Hess, S., Palma, D., 2019. Apollo: a flexible, powerful and customizable freeware package for choice model estimation and application. J. Choice Model. 32 https://doi.org/10.1016/j.jocm.2019.100176.

Jaller, M., Palwa, A., 2020. Evaluating the environmental impacts of online shopping. Behav. Transport. Approach 80, 102223.

Jones, K., 2020. How Covid-19 Consumer Spending Is Impacting Industries?. https://www.visualcapitalist.com/consumer-spending-impacting-industries/. (Accessed 27 April 2020).

Kilcarr, S., 2013. E-Commerce and Transportation?. https://www.fleetowner.com/industry-perspectives/trucks-at-work/articles/21688345/e-commerce-and-transportation. (Accessed 27 April 2020).

Kim, Y., Kang, J., Chun, H., 2022. Is online shopping packaging waste a threat to the environment? Econ. Lett. 214, 110398 (Elsevier).

Koch, J., Frommeyer, B., Scheve, G., 2020. Online shopping motives during the Covid-19 pandemic – Lessons from the crisis. Sustainability 12 (24), 10247. https://doi.org/10.3390/su122410247.

Kuoppamaki, S., Taipale, S., Wilska, T., 2017. the use of mobile technology for online shopping and entertainment among older adults in Finland. Telematics Inf. 34, 110–117.

Lee, R., Sener, I., Mokhtarian, P., Handy, S., 2017. Relationships between the online and in-store shopping frequency of Davis, California residents. Transport. Res. Part A 100, 40–52.

Miyatake, K., Nemoto, T., Nakaharai, S., Hayashi, K., 2016. Reduction in consumers’ purchasing cost by online shopping. Transport. Res. Proc. 12, 656–666.

Muller, A., Steins-Loorerb., S., Trotzke, P., Vogel, B., Georgiadou, E., Zwan, M., 2019. Online Shopping in treatment-seeking patients with buying-shopping disorder. Compr. Psychiatr. 94. Elsevier.

Potoglou, D., Susilo, Y.O., 2008. Comparison of vehicle-ownership models. Transport. Res. Rec. 2076 (1), 97–105.

PWC, 2022. A Time for Hope: Consumers
Growth Impact Our Transportation Network?. Case Stud. Therm. 2024 (Accessed 17 July 2020).

PWC, 2022. Number of Online Grocery Purchasers in the United States from 2018 to 2024. https://www.statista.com/statistics/272362/online-grocery-purchasers-united-states/. (Accessed 1 May 2022).

Santos, A., McCuckin, N., Nakamoto, H.Y., Gray, D., Liss, S., 2011. Summary of Travel Interdisciplinary Perspectives, vol. 14. Elsevier. 100580.

Shen, H., Naminpour, F., Liu, J., 2022. Investigation of Online Grocery Shopping and Delivery Preference before, during, and after Covid-19'. Transportation Research Interdisciplinary Perspectives, vol. 14. Elsevier. 100175.

Smithson, D., 2018. Mary’s at oaks mall closing’. Gainesv. Sun. March 1st, 2019. https://www.gainesville.com/news/20180304/mays-at-oaks-mall-closing.

Statista, 2020. ‘Retail e-commerce sales in the United States from 2017 to 2024’. https://www.statista.com/statistics/272391/us-retail-e-commerce-sales-forecast/. (Accessed 17 July 2020).

Statista, 2022. Number of Online Grocery Purchasers in the United States from 2018 to 2024. https://www.statista.com/statistics/1032362/online-grocery-purchasers-united-states/. (Accessed 1 May 2022).

Stapel, E., Polak, J., 2017. Incorporating online shopping into travel demand modeling: challenges, progress, and opportunities. Transport Rev. 38 (5), 576–601.

Sun, X., Wandelt, S., Zheng, C., Zhang, A., 2021. Covid-19 pandemic and air transportation: Successfully navigating the paper hurricane. J. Air Transport. Manag. 94, 102062 https://doi.org/10.1016/j.jairtraman.2021.102062. Elsevier.

Suyanto, B., Subhaktos, H., Srimulyo, K., 2019. Data of the patterns of youth local brand product consumption through online shopping. Data Brief 23, 103723.

Thaichon, P., 2017. Consumer socialization process: the role of age in children’s online shopping behavior. J. Retailing Consum. Serv. 34, 38–47.

The Economist, 2017. Stores Are Being Hit by Online Retailing. https://www.economist.com/special-report/2017/10/26/stores-are-being-hit-by-online-retailing. <visited on 03/01/2018.

Tian, X., An, C., Chen, Z., Tian, Z., 2021. Assessing the impact of Covid-10 pandemic on urban transportation and air quality in Canada. Sci. Total Environ. 756, 144270 https://doi.org/10.1016/j.scitotenv.2020.144270.

U.S. Bureau of Labor Statistics, 2022. ‘TID: the Economics Daily’. https://www.bls.gov/opub/ted/2022/consumer-prices-up-7-5-percent-over-year-ended-january-2022.htm. (Accessed 27 March 2022).

U.S. Department of Transportation, Federal Highway Administration, 2017. National household travel survey. URL: http://nhts.octrl.gov.

U.S. Department of Commerce, 2022. U.S. Census Bureau News. https://www.census.gov/retail/index.html#ecommerce (Accessed 1 May 2022).

Venables, W.N., Ripley, B.D., 2002. Modern Applied Statistics with S fourth Edition. New York, ISBN 0-387-95457-0.

Walmart, 2021. Walmart Introduces Walmart+. https://corporate.walmart.com/newsroom/2020/09/01/walmart-introduces-walmart. (Feb. 6, 2021).

Whiteland, D., 2020. These chains have announced a ton of store closings in 2019. Moneywise (visited on 03/01/2019). https://moneywise.com/a/retailers-closing-stores-in-2019.

Wickham, H., Averick, M., Bryan, J., Chang, W., mcgowan, L.D.A., François, R., Grolemund, G., Hayes, D., Miller, A., Miller-Maclaren, D., pins, E., Robinson, T.,. 2019. Welcome to the tidyverse. J. Open Source Software 4 (43), 1686. https://doi.org/10.21105/joss.00802.

Wickham, H., Averick, M., Bryan, J., Chang, W., mcgowan, L.D.A., François, R., Grolemund, G., Miller, A., Miller-Maclaren, D., pins, E., Robinson, T.,. 2019. Welcome to the tidyverse. J. Open Source Software 4 (43), 1686. https://doi.org/10.21105/joss.00802.

Wickham, H., Averick, M., Bryan, J., Chang, W., mcgowan, L.D.A., François, R., Grolemund, G., Miller, A., Miller-Maclaren, D., pins, E., Robinson, T.,. 2019. Welcome to the tidyverse. J. Open Source Software 4 (43), 1686. https://doi.org/10.21105/joss.00802.

Yutani, H., 2019. Welcome to the tidyverse. J. Open Source Software 4 (43), 1686. https://doi.org/10.21105/joss.00802.

Zhang, X., Li, Z., Wang, J., 2021. Impact of Covid-19 pandemic on energy consumption and carbon dioxide emissions in China’s transportation sector. Case Stud. Therm. Eng. 26, 101091. https://doi.org/10.1016/j.csite.2021.101091. Elsevier.