COMPARING THE IMPORTANCE OF TRIPS AND MODAL CHOICE BEFORE AND DURING COVID-19 IN METRO MANILA, PHILIPPINES

Dianne ANCHETA[1], Ryuichi TANI[2] and Ken-etsu UCHIDA[3]

[1]Student member of JSCE, Doctoral student, Graduate School of Engineering, Hokkaido University
(Kita 13, Nishi 8, Sapporo, Hokkaido, Japan)
E-mail:arch.dianneancheta@gmail.com
[2]Member of JSCE, Assistant Professor, Faculty of Engineering, Hokkaido University
(Kita 13, Nishi 8, Sapporo, Hokkaido, Japan)
E-mail:r-tani@eng.hokudai.ac.jp
[3]Member of JSCE, Professor, Faculty of Engineering, Hokkaido University
(Kita 13, Nishi 8, Sapporo, Hokkaido, Japan)
E-mail: uchida@eng.hokudai.ac.jp

Due to various mobility restrictions and the risk of contracting COVID-19 by traveling, trip activities were prioritized and modal choice was carefully considered by commuters. The objective of this study is to understand the change in trip importance and transport mode importance before and during the COVID-19 pandemic in Metro Manila, Philippines. To achieve this, data from an online questionnaire survey was collected, covering questions on socioeconomic characteristics and weekly trips made. This study then finds the importance of each trip and modal choice by using the multinomial logit model. Finally, the model parameters were calibrated by maximizing the likelihood function. Results for the data before and during COVID-19 were compared, and showed that the trip to work became less important after the pandemic started, while the importance of the trip to groceries increased. These show that because some occupation types could be shifted from on-site work to a telework setup, trips to the workplace became less important. Furthermore, the increased volume of home cooking, in addition to the closing down of food establishments, made trips to groceries more important.

Key Words : *trip importance, modal choice, COVID-19, Philippines*

1. INTRODUCTION

Trip activities, travel behavior, and transport mode preference have significantly changed as we tried to adapt and live through the COVID-19 pandemic. Commuters' travel choices have since then been affected and shaped not only by mobility restrictions in effect, but also by a combination of their socioeconomic group, and their own assessment of prioritizing trips in order to minimize risk of exposure to the Coronavirus.

Transportation constraints in response to containing virus spread have resulted in radical changes in travel behavior. Non-essential workers were forced to work from home, schools shifted to e-learning, brick-and-mortar shops were required to close; consequently, consumers resorted to food delivery and online shopping (ADB, 2020). Furthermore, various studies have shown significant differences in travel activities and modal choices between socioeconomic groups which affect their risk of exposure to Coronavirus. For instance, women use public transportation more often than men to travel for work increasing their probability of virus exposure (Assoumou Ella, 2021). In addition, mobility drops in Fance were also strongly associated with workers employed in sectors highly affected by lockdowns (Pullano et al., 2020). These studies provide evidence that changes in travel behavior may be different across different social groups.

Furthermore, non-pharmacologic interventions such as, teleworking and social distancing, have been globally implemented measures to mitigate the spread of the virus. Considering various mobility restrictions, in addition to the risk of contracting COVID-19 by traveling, commuters needed to consider the importance of making specific trips and what transport mode should be used. Trip activities

were prioritized and modal choice was carefully considered. As a result, a change in importance of trips and modal choice may possibly be observed among travelers.

Based on these aforementioned hypotheses, the objective of this study is to identify the changes in travel behavior among social groups, and assess the change in the importance of trips and modal choice before and during the COVID-19 pandemic in Metro Manila, Philippines.

The research structure will be as follows:

Section 2 describes details of the methodology. This includes data collection and the procedures of analysis, namely: multinomial logit model and maximizing the likelihood function.

Section 3 provides details on the results and discussion. The section includes evaluation of travel behavior change using Sankey diagrams and results generated from the logit model and maximized likelihood function.

Section 4 summarizes the main findings of this study.

2. METHODOLOGY

(1) Data source

The data used for this study was based on an online survey distributed to households residing in Metro Manila, and was conducted from June 1 to July 31, 2021. The survey includes questions on socioeconomic characteristics and the travel activities of the respondents before and during COVID-19. After data cleaning, a total of 140 responses were used in the analyses. Moreover, the travel activities recorded include work, grocery and recreational trips, which are further described by transport mode, frequency, duration, and fare.

The mobility indicators (work, grocery and recreation) were selected based on themes found in existing studies exploring the relationship between COVID-19 and travel behavior. For instance, the number of new COVID-19 daily infections indicates some form of positive linear correlation with visits to workplaces (Camba and Camba, 2020). In the Philippines, the major reason for traveling before the pandemic was work-related but has shifted to buying essentials or for leisure or recreation since the pandemic (Mayo et al., 2021). Such findings became the basis of formulating the hypothesis that there are changes in travel behavior due to the various mobility restrictions to mitigate virus spread, as well as the risk perception of contagion.

(2) Multinomial logit model

Firstly, the generalized cost of each respondent $k \in K$ who made trip $i \in I$ was identified and computed using the following equation:

$$g_i^k = p_i^k + \tau \cdot t_i^k \quad k \in K, i \in I \tag{1}$$

where K is the set of respondents and $I = \{w, g, r\}$ is the set of trip purposes where *w*, *g* and *r* represent work, grocery and recreation, respectively. g_i^k, p_i^k and t_i^k are the generalized cost, the trip fare and the travel time of the respondent *k* using transport mode *i*, respectively. τ is the value of time in this study (2.03PHP/min*) .

**121.67PHP/hour (Pique and Fillone, 2018) or approximately 305.15JPY/hr.*

Using the generalized cost, the utility of every trip was calculated. The parameterization of the model is represented as:

$$v_{i,s}^k = g_i^k + \alpha_{i,s} + \beta_{j,s} \qquad k \in K, i \in I, s \in S \tag{2}$$

where $v_{i,s}^k$, $\alpha_{i,s}$ and $\beta_{j,s}$ are the utility for trip purpose of $i \in I$ under $s \in S$, the trip purpose specific constant for $i \in I$ under $s \in S$, and the mode specific constant for $j \in J$ under $s \in S$, respectively. $J = \{pc, pt, a\}$ is the set of transport modes where *pc*, *pt* and *a* represent private car, public transport and active transport, respectively. $S = \{n, c\}$ is the set of states where *n* and *c* represent normal and Covid-19, respectively.

Next, the cumulative trips for each respondent were assessed utilizing the logit equation of probability. The model is formulated as:

$$p_{i,s}^k = \frac{\exp(v_{i,s}^k)}{\sum_{l \in I} \exp(v_{l,s}^k)} \quad \forall k \in K, \forall i \in I, \forall s \in S \tag{3}$$

where p_i^k is the probability of respondent *k* choosing trip purpose of *i* under state *s*.

(3) Parameter estimation

Finally, to represent the importance of each trip purpose and transport mode, the following likelihood function was maximized.

$$\max \sum_{s \in S} \sum_{k \in K} \sum_{i \in I} (p_{i,s}^k)^{f_{i,s}^k} \tag{4}$$

w.r.t $\alpha_{i,s} \left(\forall i \in I, \forall s \in S\right)$ and $\beta_{i,s} \left(\forall j \in J, \forall s \in S\right)$,

where $f_{i,s}^k$ is the frequency of trips with the purpose of $i \in I$ made by respondent $k \in K$ under $s \in S$.

Furthermore, this analytical procedure was applied to trip activity data before and during COVID-19 to compare changes in the resulting maximized functions.

3. RESULTS & DISCUSSION

(1) Population distribution

The respondents are composed of socioeconomic groups described in Table 1. The majority of demographics are represented by upper middle income and above households (49%), women (58%) middle age group (66%), and those who belong to non-essential or non-health related occupations (74%). Furthermore, the representativeness of the sample data was verified by comparing with national statistics, and shows a generally similar demographic composition.

Table 1 Sociodemographic composition of respondents

Group based on	Composition (%)	National statistics*
Household income	Poor to low-income: 7% Lower middle to middle income: 44% Upper middle income and above: 49%	Poor to low-income: 7.8%
Gender	Female: 58% Male: 42%	Female: 51% Male: 49%
Age	Below 18: 12% 18 to 60: 74% Above 60: 14%	0 to 14: 29% 15 to 64: 68% 65 and above: 3%
Occupation**	Essential: 26% Non-essential: 74%	(No available data)

**Source: Philippine Statistics Authority*

***Essential workers are those who perform health and safety services, or those whose nature of work cannot be performed thru telework. Meanwhile, non-essential workers are those employed in non-crucial occupations and have the option to work from home.*

(2) Changes in travel behavior before and during COVID-19

Using the collected data on travel activities before and during COVID-19, the change in modal choice is presented using Sankey diagrams. A general observation of the responses (Figure 1) showed that there had been a significant decrease in the overall travel demand (55%) due to various travel restrictions implemented to mitigate virus transmission. It can also be observed that most of the commuters who continued to travel during the pandemic opted to use private transport (29%) more than other transport modes. While a significant shift to private modes due to high-risk perception in public transport was noted in other studies (Zhang et al., 2021; Abdullah et al., 2020; Bhaduri et al., 2020), only a minimum shift can be observed from the data. Upon closer observation, 82% of trips which continued to use public transport are characterized by trip durations of less than 30 minutes. It can be hypothesized that in modal choice, the overall benefits of using public transport, including reduced cost, unnecessary parking, convenience and efficiency, can outweigh the risk of virus contraction, especially for short distance trips. Furthermore, the risk can be minimized even further by following social distancing protocols and proper hygiene.

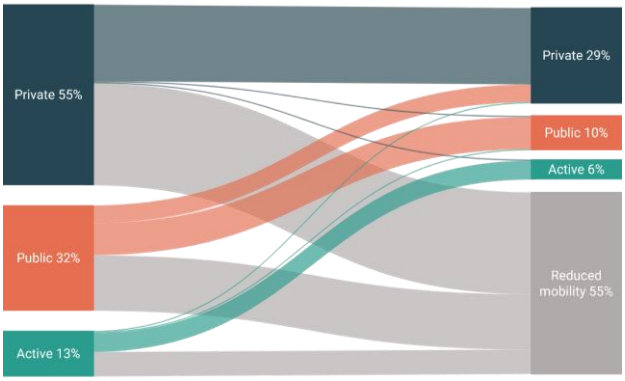

Figure 1 Change in modal choice of the respondents from before to during COVID-19

The change in the modal choice before and during COVID-19 between essential and non-essential workers was also compared (Figure 2). The increased reliance on private vehicles due to the perceived risk of public modes (Politis et al., 2021; Bucksy, 2020; Meena, 2020) was also observed in the research data. Results showed that private transport was the most preferred mode for workers who continue to travel during the pandemic, for both essential (61%) and non-essential (48%) workers. In addition, more non-essential workers reduced their mobility (32%) compared with essential workers (13%). These support previous studies stating that the capacity to stay at home during the pandemic has been constrained, not only by socioeconomic status, but also by work circumstances (Sy et al., 2020). As economic activities slowly resumed, certain service-related industries reopened following strict health protocols; however, telework continued for industries which can still function in a work-from-home setup. Thus, essential workers who continue to travel are at elevated risk of infection compared to the rest of the population (Milligan et al., 2021).

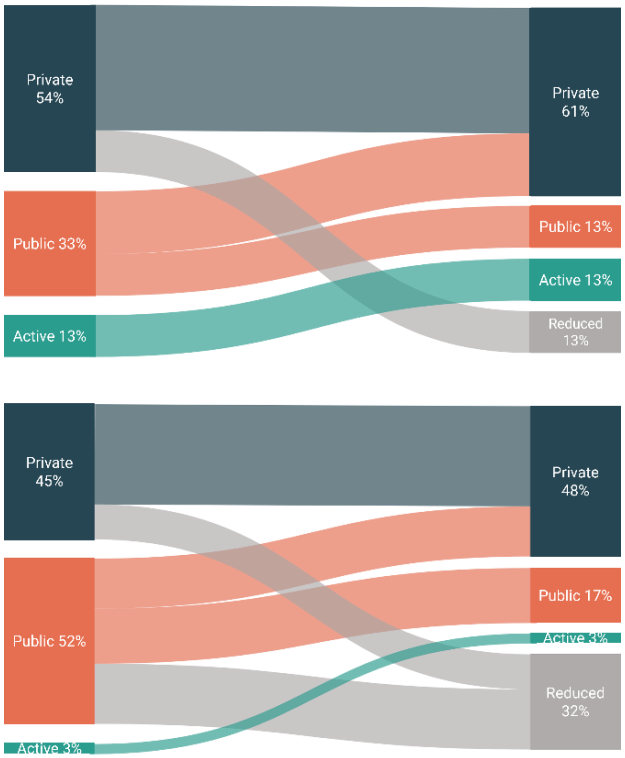

Figure 2 Change in modal choice between essential (top) and non-essential (bottom) workers

Comparing the modal choice change between female and male commuters (Figure 3), it can be observed that more women used public transport (43%) than men (30%) before COVID-19. During the pandemic, more men continued to use public transport (35%), while fewer women did (28%). Similar to earlier studies, more women reduced mobility (55%) compared with men (41%). In Southeast Asia, the Philippines had the most displaced workers, and women were more likely to exit the labor force following job loss than men (HCT, 2020). Employment loss, displacement of livelihood activities, and quarantine restrictions, whilst lessening mobility, caused women to take a disproportionate share in housework (Dizon and Medina, 2020), childcare and homeschooling, and care for ill relatives (ADB, 2021; HTC, 2020).

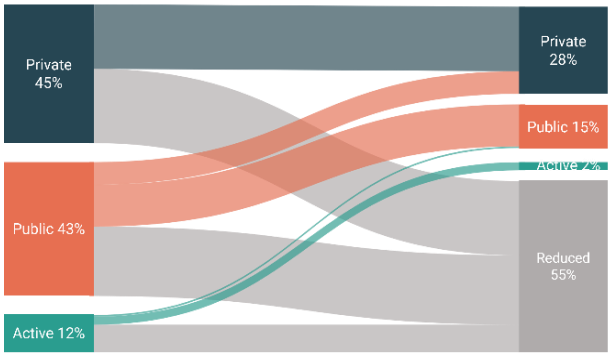

Figure 3 Change in modal choice between female (top) and male (bottom)

(3) Changes in importance of trips and modal choice before and during COVID-19

Variables	Before COVID-19	During COVID-19
Work	2.87	1.90
Grocery	-4.12E-06	5.91E-07
Private mode	3.24	2.44E-05
Public mode	-1.87	-1.49E-05

Findings from the multinomial logit model and parameter estimation represent the importance of trips and modal choice, and are presented in Table 2. Comparing the results for the data before and during COVID-19, it can be observed that the trip to work became less important during the pandemic. It can be assumed that because some occupation types could be shifted to telework or work from home setup, the importance of traveling for work lessened. However, the authors do note that majority of the respondents belong to non-essential industries (74%). Therefore, this theory may be true only for those whose occupation belong to non-essential industries, with the option and means to perform home-based work. Certain critical occupations, such as those in the health care sectors and transportation industries, have no other option but to work on site. Therefore, traveling for work is essential for them. Further studies may be employed to compare this change in importance between the two occupation groups to verify the hypothesis. Nonetheless, the results provide empirical evidence that certain work trips are not as essential during a pandemic situation, and that an alternative work arrangement is plausible.

On the other hand, trip to groceries showed an increase in importance, and this result may be associated with the increased frequency and volume of home cooking. During the early phase of the pandemic, lockdown policies required people to stay at home and certain businesses, like food establishments, to halt operations. More family members were

expected to stay put at residences, and with no option to dine at restaurants, aside from occasional food deliveries, cooking at home became the safest and most cost-efficient way for food consumption (ADB, 2020). To satisfy the basic need for nutrition, coupled with an increased amount of food preparation, trip to grocery became even more important during the pandemic. Such findings demonstrate how grocery trips have to be considered an essential activity, and that it must be included in strategies and policymaking in order to allow grocery visits whilst community lockdowns are implemented.

Findings also reveal that the importance of using private vehicles decreased during Coronavirus; in contrast, the importance of using public vehicles increased. These results further emphasize the importance of public transport especially during a pandemic. In cities of developing countries where public transport is the chosen mode especially for day-to-day subsistence activity (Bandyopadhyay, 2020), those without access to private vehicles were disproportionately affected by lockdowns and mobility restrictions having less, if no, other option to travel. Moreover, only 12% of the working force can work from home, and only 25% of the occupations in the Philippines can be conducted via telework (Gaduena et al., 2020). With fewer industries which can work remotely, and more people dependent on mass transit for mobility, the importance of public transport for guaranteeing access and continuity of basic services is even further highlighted. Results provide empirical evidence implying the focus of infrastructure developments should be geared towards improving public transport. The authors also point out that while other studies showed a general decline in public transport use and inclination of using private modes during the pandemic (Abdullah et al., 2021; Abdullah et al., 2020; Bucsky, 2020; Meena, 2020), this study focuses on determining the change in importance, not the preference, of transport mode. Furthermore, importance and preference do not necessarily correlate; thus, further analysis is required to determine any underlying relationship between the two factors.

Moreover, the difference in tendencies between the importance and preference of transport mode choice also presents a challenging scenario in achieving sustainability in transportation. As earlier mentioned, studies showed commuters prefer private cars especially during COVID-19; however, mass shift to driving would make cities even more congested and polluted than they already are, and in many cases, not everyone can afford a car, especially in developing countries. Commuters must regain confidence in using public transport again by adopting policies and strategies which will lessen the risk of virus transmission during a pandemic event.

Furthermore, as we examine the generated values for each variable, it can also be observed that there were several factors which affected trip choice of travelers before COVID-19. Specific constants were generated for the variables *Work*, *Private mode*, and *Public mode* which implies that these factors also influenced the trip choice of commuters before COVID-19. In comparison, the values for trip modes during the pandemic are both approaching zero. From these results, it can be hypothesized that transport mode did not significantly impact the trip choice of commuters during the pandemic. After COVID-19, only two factors, the generalized cost and purpose specific constant of *Work*, influence the commuters' trip choice. These findings further emphasize that despite mobility restrictions to mitigate virus transmission, work remains to be an important factor in trip choice even during the pandemic, and this may be due to the difference in nature of work (Sy et al., 2020). As previously stated, the capacity to stay at home is not only dependent on social status, but also by type of work. Some occupation cannot be performed via telework; thus, depending on their job, workers still needed to make work trips despite COVID-19.

4. CONCLUSION

This research aimed to identify the changes in travel behavior among social groups, and assess the change in the importance of trips and modal choice before and during the COVID-19 pandemic in Metro Manila, Philippines. Using data collected from an online survey, changes in travel behavior were assessed by using diagrams and likelihood maximization.

Results from this study showed how various social groups changed their travel behavior compared with others. Women and essential workers are more at risk of exposure to the Coronavirus due to transport mode choice and continued mobility, respectively. Furthermore, the change in importance of trips and modal choice before and during COVID-19 was also presented. It was found that trips to workplace became less necessary, while trips to groceries increased in importance. In addition, the use of private vehicles became less important during the pandemic, while using public transport gained more importance. Moreover, there became less factors which affected commuters' trip choice during the pandemic. Specifically, the generalized cost and *Work* specific constant contribute significantly to this choice.

These findings represent a portion of how the transport behavior of the Metro Manila population

was influenced by the Coronavirus situation. This empirical evidence could be used by policymakers in prioritizing developments directed towards essential trips and mass transport, while addressing the health safety issues brought about by a pandemic.

For future studies, further analyses can be conducted by understanding the benefit loss experienced pre-COVID-19 to present. This can be achieved by applying other methodological approach, such as utility maximization formulation. Furthermore, another temporal analysis can also be conducted considering other time periods such as early and late COVID-19, where travel behavior can also be influenced by vaccine administration.

REFERENCES

1) Abdullah, M., Nazam Ali, Muhammad Ashraf Javid, Charitha Dias, Tiziana Campisi, Public transport versus solo travel mode choices during the COVID-19 pandemic: Self-reported evidence from a developing country, *Transportation Engineering*, Volume 5, 2021.
2) Abdullah, M., Dias, C., Muley, D., Md. Shahin, Exploring the impacts of COVID-19 on travel behavior and mode preferences, *Transportation Research Interdisciplinary Perspectives*, Volume 8, 100255, ISSN 2590-1982, 2020.
3) Asian Development Bank (ADB) : COVID-19 and transport in Asia and the Pacific – Guidance note, *Asian Development Bank*, 2020.
4) Assoumou Ella, G., "Gender, Mobility, and Covid-19: The Case of Belgium," *Feminist Economics*, 27:1-2, 66-80, 2021.
5) Bandyopadhyay, S., Public transport during pandemic, *Clean Technology Environment Policy*, editorial, 22(9), 1755-1756, 2020
6) Bhaduri, E., Manoj, B.S, Wadud, Z., Goswami, A., Choudhury, C., Modelling the effects of COVID-19 on travel mode choice behavior in India, *Transportation Research Interdisciplinary Perspectives*, Volume 8, 100273, ISSN 2590-1982, 2020.
7) Bucsky, P., Modal share changes due to COVID-19: The case of Budapest, *Transportation Research Interdisciplinary Perspectives*, Volume 8, 100141, ISSN 2590-1982, 2020.
8) Camba, A.C.J., Camba, A.L., The Effects of Restrictions in Economic Activity on the Spread of COVID-19 in the Philippines: Insights from Apple and Google Mobility Indicators," *The Journal of Asian Finance, Economics and Business.* Korea Distribution Science Association, 7(12), pp. 115–121, 2020.
9) Gaduena, A., Caboverde, C., and Flaminiano, J. Telework potential in the Philippines. *Asian Institute of Management – RSNPCC*. Discussion Paper 2020-004. 2020.
10) Mayo, F.L., Maglasang, R.S., Moridpour, S., Taboada, E.B., Exploring the changes in travel behavior in a developing country amidst the COVID-19 pandemic: Insights from Metro Cebu, Philippines, *Transportation Research Interdisciplinary Perspectives*, Volume 12, 100461, ISSN 2590-1982, 2021.
11) Meena, S., Impact of novel Coronavirus (COVID-19) pandemic on travel pattern: A case study of India. *Indian Journal of Science and Technology*, 13(24): 2491-2501, 2020.
12) Milligan WR, Fuller ZL, Agarwal I, Eisen MB, Przeworski M, et al., Impact of essential workers in the context of social distancing for epidemic control. *PLOS ONE* 16(8): e0255680, 2021.
13) Pique, G. M. : Determining the value of time for a proposed expressway along C5, Metro Manila, *25th Annual Transportation Science Society of the Philippines Conference*, 2018.
14) Politis I, Georgiadis G, Papadopoulos E, Fyrogenis I, Nikolaidou A, Kopsacheilis A, Sdoukopoulos A, Verani E., COVID-19 lockdown measures and travel behavior: The case of Thessaloniki, Greece. *Transportation Research Interdisciplinary Perspectives*, Volume 10, 100345, ISSN 2590-1982, 2021.
15) Pullano, G., Eugenio Valdano, Nicola Scarpa, Stefania Rubrichi, Vittoria Colizza, Evaluating the effect of demographic factors, socioeconomic factors, and risk aversion on mobility during the COVID-19 epidemic in France under lockdown: a population-based study, *The Lancet Digital Health*, Volume 2, Issue 12, Pages e638-e649, ISSN 2589-7500, 2020.
16) Sy, KTL, Martinez, M., Rader, B., White, L. Socioeconomic disparities in subway use and COVID-19 outcomes in New York City, *American Journal of Epidemiology*, Volume 190, Issue 7, 1234–1242, 2020.
17) Zhang, J., Hayashi, Y., Frank, L., COVID-19 and transport: Findings from a world-wide expert survey, *Transport Policy*, Volume 103, Pages 68-85, ISSN 0967-070X. 2021.

(Received September X, 2022)