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## **FACTORS INFLUENCING PRE- AND POST-COVID-19 TRANSPORT MODE SHIFT IN WORKPLACE TRAVEL**

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### **Abstract**

The current modal share between private and public transport in Malaysia still falls short of its 50:50 goal. The continued reliance on private transport for workplace travel faces further aggravation in light of the Covid-19 pandemic. Aiming to understand this concern, this study pursued two key objectives; (i) to explore shifts in transport mode choices before and after Covid-19; and (ii) to identify the significant factors influencing these shifts. This cross-sectional study was conducted in Kuala Lumpur, Malaysia, focusing specifically on workplace commuting (n=113). The McNemar's test was used to determine the significance of transport mode shifts from public to private transport and vice versa, while the Mann-Whitney U test was employed to determine the significance of various factors on these shifts. Four primary factors were examined: cost, accessibility, comfort, and hygiene concerns. The findings showed that (i) a discernible shift in transport modes occurred ( $Q= 38.72, p>.05$ ), with a notable trend of individuals transitioning from public to private transport due to the Covid-19 pandemic; (ii) hygiene concerns (mean rank= 72.36,  $U= 807.0, p<.000$ ) and comfort (mean rank= 64.73,  $U= 1188.5, p= .013$ ) emerged as statistically significant influencers of this shift; and (iii) while cost (mean rank= 65.28,  $U= 1053.5, p= .001$ ) is an important determinant of transport mode preferences, it was not found to be a significant factor driving mode shifts. A comprehensive examination of pandemic-induced transport mode preferences yields crucial insights for shaping transportation infrastructure and services, facilitating sustainable development in line with UN SDGs. Understanding these influences is vital for effective policy-making and achieving desired modal shares.

**Keywords:** Transport Mode Shift, Mode Choice, Modal Share, Modal Split, Covid-19

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## INTRODUCTION

The rate of urbanisation is intrinsically linked to the increase in population density per square kilometre (Deuskar, Baker & Mason, 2015). Consequently, heightened urban activities often lead to a rise in the demand for vehicular travel (Dulac, 2013). The 2018 Revision of the World Urbanization Prospects (United Nations, 2019) projected that cities worldwide will host an additional 2.5 billion inhabitants by the year 2050. This means that approximately 68% of the global population will identify as urbanites by that time. To put things into perspective, Southeast Asian nations alone are expected to surpass a total collective urban population of approximately 500 million by 2050 (United Nations, 2019), due to the consistent upward trajectory in urbanisation rates across the region in recent decades.

As demonstrated by reports indicating stable economic growth in middle-income developing Southeast Asian countries such as Malaysia (International Monetary Fund, 2018), the persistent shifts in demographic, migration and economic characteristics are inevitably influencing the patterns of vehicle travel, especially in the context of workplace mobility. Given that commuting between one's residence and workplace is an integral aspect of urban living, a deeper understanding of the factors that can encourage increased public transport utilisation for this purpose is highly necessitated.

The transportation infrastructure and service systems in Kuala Lumpur, Malaysia are undergoing continuous improvements to benefit its inhabitants (Hashim, 2021). Currently, it boasts the most extensive variety of transportation modes in comparison to other urban centres in the country, encompassing buses, taxis, e-hailing services, monorails, light rail transit, and commuter trains. Aligned with Malaysia's National Transportation Policy 2019 – 2030, increasing public transport modal share is one of the key benchmarks for achieving an improved transportation system for the country.

The motivation behind this study stems from the observation that while the Ministry of Transport Malaysia (2018) reported a concerning 79% reliance on private transport compared to a mere 21% utilisation of public transport prior to the onset of Covid-19, there was room for optimism when Bursa Malaysia (2020) noted a slow but promising pattern of increase in public transport utilisation from 2016 to 2018, as evidenced by daily average ridership figures for both rail and bus services. Although public transport utilisation only managed to capture a modal share of 21% in 2018 – considerably below the Ministry of Transport Malaysia's anticipated goal of 40% in 2020 – this slow but encouraging trend, especially for workplace commuting, faced unforeseen disruption with the event of Covid-19.

On this note, the evolving landscape of the working environment, with a notable shift towards remote work arrangements and a higher dependency on

technological advancements (Lim, et al., 2022), may further change the travel behaviours of urban residents. Conversely, the prevalent reliance on private transport, despite the presence of well-established public transport infrastructure and services, raises significant concerns among government agencies. As such, it becomes imperative to understand the factors that either foster or hinder the inclination towards adopting public transportation as the primary mode of urban mobility and movement.

Furthermore, in alignment with the transport-related goals and targets outlined in the United Nations' Sustainable Development Goals (SDGs) of 2015, there is a call for countries to enhance urban accessibility through the development of sustainable infrastructure. This essentially entails providing urban inhabitants with improved transportation services that facilitates physical mobility between destinations. The associated SDGs also highlight the need of providing transportation infrastructure and services that are not only safe and affordable, but also readily accessible to the general populace, with special consideration for vulnerable and underserved segments of society, including women, children, the disabled, and the elderly.

To address and gain a better understanding of the aforementioned predicament, the study outlined two primary objectives; (i) to investigate whether a discernible shift in transport mode preference occurred for commuting to the workplace during two distinct time frames, i.e. pre- and post-Covid-19; as well as (ii) to examine whether there exists a significant disparity in the perceived importance of factors influencing transport mode choice between individuals who have undergone a mode shift, both in the pre- and post-Covid-19 periods. The study focused on four factors that were found to have significant impacts on an individual's choice of transport mode, namely cost, accessibility, comfort and hygiene concerns.

Cost consistently stands out as a major factor influencing the selection of transportation mode. While various studies have demonstrated that individuals of different gender, age groups and monthly household incomes may react differently to travel costs (Zyed et al., 2014; Mayo & Taboada, 2020), this does not negate the fact that financial considerations wield significant influence across most socio-demographic characteristics (Outwater et al., 2003). Typically, those opting for public transport tend to incur lower expenses compared to those who opt for private transport. Moreover, most individuals who opt for public transport often exhibit heightened concern and sensitivity towards travel costs (Ismail, et al., 2021). Consequently, the reduced cost of public transport becomes an enticing factor and a motivator for sustained utilisation (Maia, et al., 2020).

Accessibility to transport infrastructure and services is deemed a more important factor in the decision-making process regarding transport mode choice, surpassing the influence of the transport system's efficacy in providing access to

one's desired destination (Brussel, et al., 2019). Supporting this, Lamanna, et al. (2020) found that limiting proximity to transit stops serves as a significant deterrent to increased public transport utilisation. Furthermore, the concept of ease of access to transportation features prominently among the many goals and targets outlined in the United Nations' SDGs. Studies have shown that heightened accessibility to one's preferred transport mode signifies an optimal level of transport equity (Martens, 2021).

The factor of travel comfort has demonstrated notable influence on transport mode choice (Shen, Chen, & Pan, 2016). In alignment with this observation, Masoumi (2019) found that individuals tend to lean towards private transport over public options, primarily due to the comfort level both modes offer. This is further substantiated by studies that highlight the discomfort in transport services provision can be a potential barrier to public transport usage, especially among the elderly (Lamanna, et al., 2020).

Hygiene concerns have surged to prominence in the wake of the Covid-19 pandemic. As articulated by Rankavat, et al (2023), the provision of hygiene features and a healthy awareness of hygiene concerns are now regarded as integral safety measures within transportation. The author further highlights that hygiene concerns emerge as a significant factor deterring individuals from opting for public transport, instead favouring private modes. This trend is hardly unexpected, given the growing apprehension and concerted precautions to mitigate the spread of Covid-19.

## **MATERIALS AND METHODS**

### **Study Design**

Employing a quantitative approach, this study aims to discern shifts in travelling mode choice before and after the Covid-19 pandemic. It specifically seeks to address two key questions: 'is there a shift in public transportation mode choice between the two periods?' and 'if so, what factor(s) influenced this shift?'. Kuala Lumpur, the capital city of Malaysia, was selected as the study locale due to several significant reasons: (i) it boasts the most variety and availability of both public and private transportation options and infrastructure compared to other regions of Malaysia, (ii) it exhibits the highest population density per square kilometre (iii) despite abundant access to public transportation services, there remains a strong dependency on private transportation, and (iv) income no longer serves as the primary indicator of transportation mode usage.

The combination of simple random sampling and stratified sampling techniques enabled the recruitment of a targeted population in an unbiased manner. The eligibility criteria for sampling is threefold, (i) adult Malaysians above the age of 18 years old who have resided and worked in Kuala Lumpur for a minimum of three years, (ii) able-bodied individuals, and (iii) those who

commute to their workplaces. Respondents were stratified based on two criteria: race, i.e. Malay, Chinese, Indian and Others, and gender, i.e. Male and Female.

The required number of respondents per category based on this stratification mirrors the demographic distribution of Malaysia in 2022. With a 90% confidence interval level and considering a population size exceeding 100,000, the sampling size calculation according to Yamane (1967) required a minimum sample size of 100 for the study. Within a span of four months (June 2022 to September 2022), the study successfully recruited 113 eligible respondents who willingly participated in the study.

The data collection method applied was a face-to-face questionnaire survey, encompassing two sections featuring both close-ended and open-ended questions. Section A was designed to elicit respondents' demographic details as well as their preferred modes of transportation both before and after Covid-19, while Section B focused on assessing their perceptions on the factors influencing their post-Covid-19 transport mode choices. The bilingual questionnaires, presented in both English and Malay, were produced through a forward translation, which were subsequently reviewed by two bilingual experts using the conceptual equivalence method as recommended by the World Health Organisation Guidelines on Translation Instruments (2020).

## **Measures**

### ***Transport Mode Choice Pre- and Post Covid-19***

The first objective of the study is to ascertain whether a shift in preferred transport mode for commuting to the workplace occurred, hence the measures of preferred transport mode choice before and after the Covid-19 pandemic are important variables of the study. Data were collected through two close-ended questions, (i) "What was your preferred mode of transportation to your workplace prior to the occurrence of Covid-19 pandemic?" and (ii) "What is your preferred mode of transportation to your workplace following the of Covid-19 pandemic?". Both questions offered respondents a similar range of responses, allowing them to choose between public transport options such as Light Rail Transit, Mass Rail Transit, KTM Komuter, Monorail, public buses, taxis, and e-hailing services; or private transport modes including cars and motorcycles. The collected responses were stored as nominal data.

### ***Factors Influencing Transport Mode Choice***

The second objective of the study aims to assess whether there exists a significant disparity in the perceived importance of factors influencing transport mode choice between individuals who have undergone a mode shift and those who have not, both before and after the Covid-19 pandemic. The study incorporates four key factors, namely cost, accessibility, comfort and hygienic concerns. These

factors were evaluated on an ordinal scale via four close-ended questions where respondents were tasked with rating the importance of each factor specifically for commuting to the workplace, utilising a 4-point Likert scale where 1: Very not important, 2: Not important, 3: Important, and 4: Very important.

To deepen the understanding of the factors, respondents were also tasked with providing responses to six additional questions, each corresponding to a specific factor. For cost and hygiene concerns, respondents were prompted to rate their perception of their current transportation cost, and the level of hygienic measures associated with their current transport mode choice. Both questions employed a 4-point Likert scale, ranging from 1: Very low to 4: Very high. These responses were treated as ordinal data.

In addition to the aforementioned close-ended questions, the survey also included four open-ended questions. Respondents were prompted to state their average monthly transportation cost to their workplace in Ringgit Malaysia (RM), the average duration for the round-trip commute from their residences to their workplaces in minutes per day, and the distance between their residences and workplaces in kilometres (km). They were also encouraged to articulate the single most important hygienic feature that should be prioritised in any mode of transportation.

### ***Demography***

The study necessitates four key demographic details from respondents. This includes their age, gender, race, and average monthly household income in Ringgit Malaysia. These information are treated as control variables for the study.

### **Data Analysis**

The data was recorded and analysed using IBM Statistical Package for Social Sciences (SPSS) version 29.0. The dataset was screened for missing values ( $n=113$ ) and unengaged responses. Four analytical methods were employed to conduct data analysis, with results interpreted at a 95% confidence interval level.

Firstly, descriptive analysis was employed to present the distribution of the collected data. Subsequently, the McNemar's test was applied to assess the presence of a significant shift in mode choice for commuting to the workplace before and after the Covid-19 pandemic. In order to be able to perform a McNemar's test, the dependent variable of the study must exhibit categorical and dichotomous characteristics. The pre- and post-Covid-19 transport mode choice data were therefore re-coded based on the occurrence of a transport mode shift. Instances where a transport mode shift occurred, in either direction, were re-coded as 1: Yes. Conversely, If the sample continued to utilise the same mode of transport, the individual was re-coded as 2: No. It is worth noting that the data is also mutually exclusive, signifying that the same individual who reported their

transport mode choice before Covid-19 also provided their transport mode choice after Covid-19.

Thirdly, the study employed the Mann-Whitney U test to assess whether the four factors, namely cost, accessibility, comfort, and hygienic concerns, significantly influenced the shift in transport mode choice for workplace commuters before and after Covid-19. Lastly, as the study also collected written responses obtained through four open-ended questions, a thematic analysis was employed to identify recurring patterns in the provided answers, which were then organised into themes to provide a better understanding of the quantitative findings.

## **RESULTS**

### **Univariate Analysis**

#### ***Demography***

The mean age of the respondents is 25.2 ( $\pm 5$ ) years. The distribution by gender showed a slightly higher percentage of male respondents (52%) over females (48%). In terms of race, the respondent demographics mirror that of the broader Malaysian population, where 58% are Malay, 21% are Chinese, 20% are Indians and 1% are from Other ethnic backgrounds. A significant majority of respondents belong to the lower-income bracket, earning an average of less than RM4,850 on a monthly basis (72%), while the remaining 28% fall into the medium-income category, with earnings between RM4,851 to RM10,970. Notably, none of the respondents are from the higher-income level, earning in excess of RM10,971.

#### ***Transport Mode Choice Pre- and Post Covid-19***

Examining the transport mode choices during the pre-Covid-19 period reveals that 78% of respondents relied on public transportation for their daily commute to work, while only 22% opted for private transportation. In contrast, the transport mode choice post-Covid-19 exemplified a notable shift, with 61% of respondents favouring private transportation over public options (39%). The demographic distribution and corresponding transport mode choices before and after Covid-19 are presented in **Table 1**.

#### ***Factors influencing Transport Mode Choice***

The perceived factors influencing transport mode choice is shown in **Table 1**. Cost is deemed an important factor in the selection of transport mode for commuting to the workplace, with 42% considering it very important and 30% deeming it important. Conversely, a mere 28% found it not and very not important. A large majority of respondents (69%) perceived the cost of their chosen transport mode for post-Covid-19 workplace commuting as ranging from high to very high. The remaining 31% regarded transportation costs as ranging

from low to very low. The analysis of open-ended question revealed that the average monthly transportation cost to work is approximately RM280. Notably, a large majority of respondents reported transportation costs to the workplace below RM400.

**Table 1.** The distribution of the respondents' demography and transport mode choice during two distinct time periods; pre- and post-Covid-19 (n= 113)

	Overall, 100%
Age, SD	25.2 (±5)
Gender, %	
Male	52
Female	48
Race, %	
Malay	58
Chinese	21
Indian	20
Others	1
Education level, %	
Without tertiary education	27
With tertiary education	73
Monthly household income, %	
≤ RM4,850	72
RM4,851 – RM10,970	28
≥ RM10,971	-
Transport mode choice pre-Covid-19, %	
Public Transport	78
Private Transport	22
Transport mode choice post-Covid-19, %	
Public Transport	39
Private Transport	61
Transport mode shift, %	
Public Transport to Private Transport	42
Private Transport to Public Transport	2
Public Transport to Public Transport	19
Private Transport to Private Transport	37

In terms of accessibility, a majority identified it as an important (59%) or very important (25%) factor influencing their choice of transport mode for commuting to work. The remaining 16% considered the accessibility of their chosen transport mode to work as ranging from low to very low. On average, respondents reported a daily round-trip travel time of approximately 40 minutes between their residences and workplaces, covering an average distance of roughly 20 kilometres (one-way). Comfort emerged as a key consideration, with 51% deeming it important and 38% rating it as a very important factor in their choice of transport mode. A minority of 11% reported that comfort was not an



important factor in their daily commute choice. Similarly, most also felt the same way about the hygiene of their chosen mode of transport, with 58% considering it very important and 38% deeming it important. Only a small fraction of 4% stated that hygiene was not an important factor during their work travels. When asked about the level of hygienic features available or precautions taken around their chosen transport mode, the majority of respondents perceived it to range from high (57%) to very high (40%). A mere 3% expressed dissatisfaction with the level of hygiene maintenance in their chosen mode of transport.

### **Bivariate Analysis**

#### ***Transport Mode Shift Pre- and Post Covid-19***

In order to identify any descriptive shifts in transport mode choice before and after Covid-19 for workplace commuting, the dataset was assessed and re-coded into 1: Shift from public transport to private transport (PT to PV), 2: Shift from private transport to public transport (PV to PT), 3: Remained with private transport (PV to PV), and 4: Remained with public transport (PT to PT). The re-coding revealed that 42% of respondents shifted from public transport to private transport. This is closely followed by 37% of respondents who remained using private transport for their work commute both pre- and post-Covid-19. Nineteen percent maintained their use of public transport during both periods. Lastly, the remaining 2% shifted from private to public transport within the same timeframe.

Next, the study conducted the McNemar's test to establish the statistical significance of the shift in transport mode choice before and after Covid-19 (refer Table 2). The null hypothesis posits that there is no significant shift in transport mode choice for workplace commuting over the two time periods. The obtained Q value is 38.72. As the study employs the 95% confidence interval level, with reference to the critical points for chi-square distribution, the value for 0.05 is 3.84. Given that the value of 38.72 exceeds 3.84, the null hypothesis is rejected. This implies that, statistically, there is a significant shift of transport mode choice before and after Covid-19, occurring in both directions, i.e. from public to private transport and vice versa.

#### ***The perceived difference of factors influencing transport mode choice***

The subsequent phase of the analysis aims to discern whether there exists a disparity in the perceived importance of factors influencing transport mode choice among respondents who have shifted their mode of transport and those who have not, both before and after Covid-19 (refer Table 2). To facilitate this, the Mann-Whitney U test is conducted with a pre-requisite of data re-coding. The transport mode choices of respondents before and after Covid-19 are transformed into dichotomous variables, denoted as 1: Shift and 2: No shift. Descriptively, it is evident that 56% of respondents maintained their original transport mode

choice over the two periods, while the remaining 44% opted to shift their mode of transport during the same timeframe.

For respondents who maintained their transport modes throughout both pre- and post-Covid-19 periods, the factor of cost (mean rank= 65.28, U= 1053.5, p= .001) emerges as a statistically significant influence on their transport mode choice. On the other hand, among respondents who did shift their transport modes during these periods, comfort (mean rank= 64.73, U= 1188.5, p= .013) and hygiene concerns (mean rank= 72.36, U= 807.0, p<.000) were found to be statistically significant factors. Finally, although accessibility (mean rank= 60.10, U= 1380.0, p= .200) is more important for those who did not shift their transport modes, this output did not reach statistical significance.

**Table 2.** Distribution of the respondents' perceived importance of factors influencing transport mode choice pre- and post-Covid-19 on a 4-point Likert scale (n= 113)

Factors influencing transport mode choice	Perceived importance of respective factors				Mean rank	Statistical difference Mann-Whitney U (p-value)
	Very not important, %	Not important, %	Important, %	Very important, %		
Cost, %	2	26	30	42		
Shift					46.57	1053.5**
No shift					65.28	(.001)
Accessibility, %	-	16	59	25		
Shift					53.10	1380.0
No shift					60.10	(.200)
Comfortability, %	-	11	51	38		
Shift					64.73	1188.5
No shift					50.87	(.013)**
Hygiene concerns, %	-	4	38	58		
Shift					72.36	807.0
No shift					44.81	(<.000)***

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.00

## DISCUSSION

The study began with the objectives of investigating transport mode shifts for workplace commuting, both pre- and post-Covid-19, as well as examining the perceived importance of factors influencing transport mode choice in these two distinct periods. This cross-sectional study, incorporating the four study factors of cost, accessibility, comfort, and hygiene, yielded several important insights that helped shed light in understanding the predicament. Empirical evidence underscores the substantial impact of Covid-19 on the behaviours of transport users, specifically for workplace commuting.

The significant shift in transport mode choice pre- and post-Covid-19 is apparent, as individuals predominantly using public transport displayed a pattern of shifting and increasing their reliance on private transport after the Covid-19 pandemic. This further underscores the pandemic's disruptive influence on modal share. Notably, individuals predominantly using private transport pre-Covid-19 largely persisted with this choice post-Covid-19. These findings align with prior studies on transport mode shifts (Purwoko & Yola, 2022) attributed to Covid-19 (Vega-Gonzalo, Gomez & Christidis, 2023).

Hygiene concerns emerged as the paramount determinant influencing an individual's daily commute choice, understandably so given the critical health implications associated with Covid-19. For those who shifted their mode of transport during the two timelines of pre-and post-Covid-19, hygiene and comfort were identified as pivotal factors. While hygiene and health are regarded as important determinants influencing transport mode choice, cost is ranked the second most important factor.

Based on the report published by the Institute of Strategic and International Studies, Malaysia (Cheng, 2020), the Covid-19 pandemic exerted substantial strain on the Malaysian economy, leading to increased unemployment. With the retraction of monthly household income and possible disposable income among Malaysian families, this economic impact naturally elevated concerns about transportation costs. This explains why cost is a significant retaining factor for those who maintained their mode of transport pre- and post-Covid-19. In other words, although cost is an important factor in influencing mode choice, it was not the primary driver for shifts in transport modes both before and after Covid-19, specifically for workplace commuting.

Understanding the factors that influence transport mode choice and the shift in transport mode choice due to a pandemic offers insight to "choice behaviours" regarding transportation infrastructure and services (Yang, et al., 2022). This lays a foundation of shaping the development and advancement of sustainable transportation policies (Ghazali, et al., 2021) as outlined by the United Nations SDGs goals and targets.

## **CONCLUSION**

The impact of cost on mode choice remains significant in determining transportation usage, yet it does not serve as the primary driver behind the observed shifts in transport mode selection during pre- and post-Covid-19, particularly for commuting to workplaces. While cost continues to be a crucial factor, the transformation in mode preferences can be largely attributed to a combination of factors. These include the growing emphasis on health and safety, with commuters prioritising modes that offer lower exposure to potential risks, such as crowded public transport. Supporting this, the study provides evidence

that hygiene concerns and comfort while travelling to workplaces are statistically significant in influencing transport mode shift due to the Covid-19 pandemic.

A limitation of the study is that it does not capture data on the specific mode of transportation used for work travel pre- and post-Covid-19. Future studies are highly recommended to explore how these factors differ across various modes of transportation. Additionally, the rise of remote work arrangements has altered traditional commuting patterns, leading to a re-evaluation of transportation needs and preferences, where factors such as convenience, flexibility, and personal well-being now hold heightened significance in the decision-making process. Navigating this evolving landscape requires a nuanced understanding of the complex interplay of these multiple influences, which is imperative for devising effective and sustainable transportation policies, especially in achieving the desired modal share within the stipulated timeline.

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