https://doi.org/10.3311/PPtr.37758



Periodica Polytechnica Transportation Engineering

# Provision of Shuttle Bus Services to Low-income Workers in Penang, Malaysia

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Received: 24 June 2024, Accepted: 16 December 2025, Published online: 03 June 2026

**Abstract**

The rapid urbanization and escalating traffic congestion in Penang, Malaysia, have intensified transportation challenges for low-income workers. While shuttle bus services are increasingly recognized as a sustainable mobility solution, there remains limited empirical research on their adoption among economically disadvantaged commuters in urban Malaysia. This study addresses that gap by exploring the factors influencing the use of shuttle bus services among low-income workers in Penang, guided by the Theory of Planned Behavior and Mobility Transition Theory. Employing a mixed-methods approach, the study integrates quantitative data from 306 respondents identified through the Penang eKasih Welfare Program 2016 – selected via stratified random sampling – with qualitative insights from 10 regular shuttle bus users. Factor analysis reveals that the most influential determinant in choosing a mode of commute is the shuttle's capacity to ensure reliable and direct access to workplaces. Notably, qualitative findings indicate that some users continue to opt for the state-provided shuttle bus despite owning private vehicles, citing significant savings on fuel, tolls, and parking as key motivators. This highlights a crucial insight: affordability and accessibility outweigh convenience for this demographic. The novelty of this study lies in its focus on shuttle services as an equity-driven transport intervention within a Malaysian urban context. The findings support the expansion of such services, particularly to employment-dense areas, and provide actionable recommendations for policymakers aiming to promote inclusive, efficient, and sustainable urban mobility.

**Keywords**

shuttle services, commuting to the workplace, dominant mode of transportation

## 1 Introduction

Transport systems degrade the environment by emitting greenhouse gases (GHGs) from fossil fuel burning. Transport causes air, noise, water, and environmental damage (IOP Science, 2023). Sustainable transport ensures accessibility, reduces negative consequences on human health and the environment, and promotes intergenerational fairness, helping achieve sustainable mobility goals.

City governments worldwide are promoting electric, hybrid, and hydrogen-powered automobiles (United States Environmental Protection Agency, 2023). However, eliminating private car use remains difficult (Sloman and Hopkinson, 2020). Private vehicles are becoming cleaner, but public transit, especially group transport, is still better at decreasing emissions and traffic.

Penang's traffic is extremely bad during peak hours, weekends, and school holidays (Dermawan, 2022). Private car use increases congestion and environmental stress (Rosli et al., 2024). Public transport is deemed insufficient and inefficient (Bernama, 2023). Since 2013, Penang has offered governmental personnel a shuttle bus service for greener commuting (Penang State Government, 2012). Shuttle buses transport employees between centralized pick-up points and KOMTAR, the state's administrative centere (Penang State Government, 2012).

This program reduces government worker car use, lowers commute costs, and promotes sustainability. Because Penang relies on private automobiles, it's crucial to study how such services affect commute preferences, especially among low-income civil servants who may be more vulnerable to mobility issues.

Thus, this study seeks to determine low-income government employees' commuting mode preferences, identify significant factors affecting their mode choices, and analyze the reasons why they prefer shuttle bus services.

**Cite this article as:** Rosli, H., Samat N. (2026) "Provision of Shuttle Bus Services to Low-income Workers in Penang, Malaysia", Periodica Polytechnica Transportation Engineering, https://doi.org/10.3311/PPtr.37758

Beyond operational or engineering-centric approaches, this research incorporates behavioral and socio-structural insights into sustainable commuting behaviors in a developing metropolitan context, filling a vacuum in the literature.

### 1.1 Shuttle bus services: Global and regional perspectives

Shuttle bus services are popular worldwide as a sustainable and practical commuting choice, especially in heavily populated urban areas. These services minimize congestion, emissions, and employee well-being by lowering travel costs, stress, and punctuality and productivity (Arnold, 2022; CMAC Group, 2023; Rahima 2024). Shuttle buses are also essential for workers who cannot use public transport (Bus.com, 2023).

Despite these benefits, most shuttle bus-related research have concentrated on technology rather than behavior or geography. In Madrid, Oikonomou et al. (2023) employed microscopic traffic modelling to examine how autonomous shuttle bus speeds affect traffic flow and the environment. Dou et al. (2019) optimized shuttle service design in two steps to maximize route efficiency and passenger comfort.

Asinas et al. (2017) examined how Metro Manila's business sector has employed shuttle services to relieve congestion by diverting employees from cars. Employer-led interventions improved productivity and behavior. Eligüzel et al. (2021) found that centralized shuttle pick-up stations for Turkish industrial workers might minimize travel distances by over 40%.

These studies provide useful operational insights but ignore socio-behavioral incentives for shuttle use, especially among low-income urbanites. In Malaysia, especially Penang, little is known about how workers use such services, what drives their transit choices, or how they fit into urban mobility systems.

### 1.2 Theoretical framework: TPB and Mobility Transition Theory

TPB and MTT are used to fill this gap in this investigation. The Theory of Planned Behavior (Ajzen, 1991) is widely used in transport studies to explain behavioral intentions based on attitudes, subjective norms, and perceived behavioral control.

TPB can be used to study the psychological aspects that influence shuttle bus utilization in Penang, where low-income government workers may encounter logistical, economic, and social limitations. An employee may take the shuttle due of convenience, management or peer motivation, or system reliability.

Additionally, Mobility Transition Theory (Sheller, 2018) examines socio-structural transport transformation. It examines how societies migrate from private vehicle dependence to sustainable mobility. MTT recognizes that supportive legislation, infrastructure upgrades, and cultural adaption are essential to transform behavior.

Penang has limited public transport and a strong car culture. The state-sponsored shuttle program is positioned as both a transportation solution and a mobility norm shifter. MTT places this intervention in the context of policy-driven transformation and structural mobility transitions.

### 1.3 Research gap and contribution

Research has focused on engineering efficiency and network design, overlooking behavioral and equity assessments, especially in Southeast Asia and Malaysia. Other nations have studied how shuttle services cut costs and enhance travel logistics, but few have addressed how marginalized or low-income public sector groups perceive and use them.

This study addresses that gap by examining low-income civil officials' commuting decisions in Penang, how socio-economic, psychological, and structural factors affect them, and integrating TPB and Mobility Transition Theory. A nuanced knowledge of transport behavior is achieved by combining individual-level decision-making and macro-level structural restrictions.

### 1.4 Transport equity and critical engagement

Mobility research emphasizes transport equity to distribute resources fairly and reduce exclusionary barriers (Lucas, 2012; Martens, 2016). Low-income urban residents, especially in emerging regions, confront exorbitant fares, insufficient connectivity, and long commutes. Well-designed shuttle bus services can alleviate these inequalities by providing reliable, low-cost transportation straight to companies.

However, Sheller (2018) and Pereira et al. (2017) advise cautious thinking about such approaches. If they ignore informal sector workers, those outside pick-up zones, or women with gendered travel patterns, well-intentioned programs may entrench exclusion. Transport equity demands understanding complicated socio-spatial processes, including who benefits, who is excluded, and why.

This study examines how inclusive or exclusive shuttle services are by focusing on low-income government employees, a neglected demographic. It explores whether Penang's state-run program improves mobility equity or reproduces access gaps.

This research contributes to the literature theoretically and practically. Integration of TPB and MTT provides for

a thorough shuttle bus adoption analysis combining psychological motives and structural restrictions. To address concerns for equity-focused transport planning, the study examines state-led policies' effects on low-income workers. This study can help Malaysia and other emerging countries improve transport policy by promoting more efficient, inclusive, sustainable, and equitable urban mobility.

## 2 Methodology

The study employed a mixed-methods approach, integrating both quantitative and qualitative procedures. Quantitative data is typically regarded as more objective than qualitative data, however it may not have the same degree of specificity. Quantitative data enables the creation of statistical datasets that may be used for comparison and analysis with other statistical measurements. Furthermore, the qualitative findings will provide significant insights by highlighting certain aspects of the study. Consequently, combining both approaches will augment the efficacy of each option, resulting in enhanced generality. The questionnaire is distributed directly to respondents, who are given a specific period of time to fill out it before it is collected. The study involved distributing questionnaires to a sample of 306 respondents. The respondents were selected using a stratified random selection approach, based on the ratio of the population of low-income households enrolled in the eKasih Penang welfare programme for the year 2016. The individuals involved in the eKasih programme in Malaysia are recorded in the national impoverishment database. The purpose of this database is to gather data on individuals living in impoverishment, irrespective of whether they are located in rural or urban areas within the country. According to the 2016 participants list of the eKasih initiative in Penang, it was discovered that a total of 1,546 households with a low-income status had enrolled in the scheme. To ascertain the ideal sample size for accurately representing the actual population, the Morgan Table, as depicted in Table 1, is consulted. Table 1 is a modified version of the whole Morgan sampling table, tailored to fulfil the unique needs of the study. The Morgan table was used to determine the sample size for the population of 1,546 low-income families. Based on this, a sample size of 306 respondents was chosen.

**Table 1** Morgan sampling table

(Modified from: Krejcie and Morgan, (1970) in Kenpro Kenya, (2012))

| Sample | Population | Sample | Population |
|---|---|---|---|
| 278 | 1000 | 302 | 1400 |
| 285 | 1100 | 306 | 1500 |
| 291 | 1200 | 310 | 1600 |
| 297 | 1300 | 313 | 1700 |

After determining the suitable size of the sample, the stratified random sampling approach was used, considering the different ethnicities mentioned in Table 2. Based on the statistics provided in Table 2, the most prevalent demographic group among the respondents is Malay men, comprising 65.03% and Malay women 18.63%, respectively. Conversely, Chinese are the smallest proportion of representation, making up only 2.94% for Chinese men and 1.96% for Chinese women.

Concurrently, qualitative data was gathered by conducting a comprehensive interview with a subset of ten low-income workers who were selected from the initial sample of 306 respondents. These individuals were low-income workers who preferred to use the shuttle bus service as their means of transportation to their workplace. This comprehensive interview was specifically done to gather the perspectives of low-income individuals regarding their preference for using the shuttle bus service as their primary means of transportation for travelling to work. The qualitative respondents in this study were interviewed face-to-face for a duration of less than one hour. The data was obtained through the process of transcribing the conversation with the respondents.

### 2.1 Study area

The geographical scope of the research encompasses the Penang state in Malaysia. The state of Penang comprises two distinct regions: Penang Island and Seberang Perai on the mainland.

These two areas are connected by ferry services as well as two bridges spanning the Malacca Strait. The first bridge measures 13.5 km in length, while the second spans 24 km (Penang State Government, 2022). The state comprises five districts. The North East district has an area of only 124 square km, whereas the South West district has an extent of only 175 square km. The remaining three districts in Seberang Perai are Seberang Perai Utara, Seberang Perai Tengah, and Seberang Perai Selatan, which have areas of 267, 238, and 242 square kilometers respectively

**Table 2** Sample size selected from low-income group in Penang

| Ethnicity | Male | Female |
|---|---|---|
| Malay | 65.03 | 18.63 |
| Chinese | 2.94 | 1.96 |
| Indian | 7.19 | 4.25 |
| Total | 75.16 | 24.84 |

(Penang State Government, 2017). The reason for selecting Penang as the research region is its status as one of the largest cities in Malaysia, now experiencing a swift process of urbanization. The trend of urbanization has stimulated the migration of people to urban regions in order to take advantage of the work possibilities that are available there (Awang Besar et al., 2020). By 2010, Penang had attained an urbanization rate of 90.8%, the second highest in Malaysia after Selangor, which recorded 91.4% (Zuan, 2014). Consequently, Penang became the second largest city in Malaysia in terms of population density, with an area of 1684 square km in 2018 (Mok, 2016). Furthermore, the reason for selecting Penang as the study region is that, although being the second largest city in Malaysia, the transportation infrastructure in this state relies exclusively on public buses. This state lacks any form of Light Rail Transit (LRT), Mass Rapid Transit (MRT), or similar transportation systems. The public transport sector in the state is insufficient to meet the mobility requirements of a sizable population. Hence, doing research on the socio-economic factors influencing individuals' transport choices, particularly among low-income populations, can effectively articulate the genuine requirements of this demographic within the transport sector. This, in turn, enables the government to enhance the sector and cater to these needs in a more targeted and effective manner.

The map in Fig. 1 is showing the location of Penang State, Malaysia – the geographical focus of this study. Penang comprises Penang Island and the mainland region of Seberang Perai, connected by two bridges and ferry services. The state was selected due to its high urbanization rate and limited public transportation infrastructure, making it a relevant setting for investigating transportation mode choices among low-income communities.

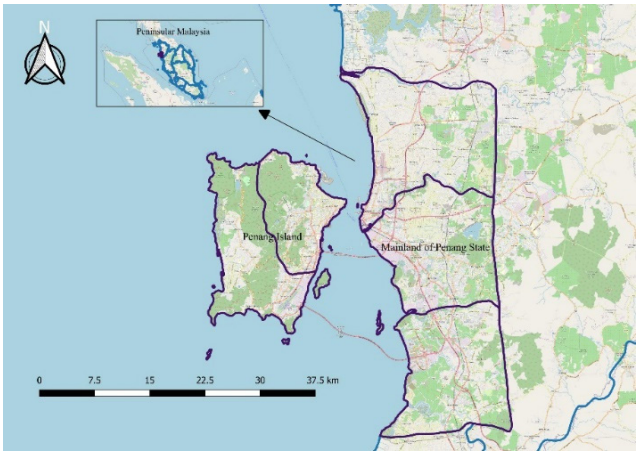


**Fig. 1** Map of Penang State, Malaysia. Map generated by the author using QGIS software (online), based on administrative boundary data from the Department of Survey and Mapping Malaysia (2023).

## 3 Findings and discussion

In essence, the gathered quantitative data were subjected to statistical analysis using cross-tabulation and factor analysis. Concurrently, the qualitative data were examined employing the content analysis methodology. The statistical quantitative study was conducted to determine the primary determinant in the selection of transport mode for low-income workers in Penang State. Conversely, the qualitative content analysis primarily aims to uncover the motivations behind respondents' selection of shuttle bus services as their primary form of transportation to their place of employment.

### 3.1 Quantitative findings

This study entails conducting statistical analysis on the key elements that exert the most influence on respondents' selection of their current mode of transportation for commuting to their workplace. It is crucial to analyze these aspects in order to accurately anticipate the actual demands of the transportation system being provided. These elements will be crucial in informing the government's efforts to address the deficiencies in public transit.

#### 3.1.1 Demographic characteristics

Table 3 provides a clear explanation of the demographic features of a group of 306 respondents. According to Table 3, the largest proportion of respondents, 83.66%, identified as Malay, while 11.44% identified as Indian, and the smallest ethnic group among respondents was Chinese, accounting for 4.90%. The majority of respondents, specifically 91.83%, were from households with incomes less USD 528.49. Specifically, only 6.87% and 1.30% of the respondents were from families with a monthly income ranging from

**Table 3** Demographic characteristics

| Ethnicity | *n* | Percentage (%) |
|---|---|---|
| Malay | 256 | 83.66 |
| Chinese | 15 | 4.90 |
| Indian | 35 | 11.44 |
| Total | 306 | 100.00 |
| Household income | *n* | Percentage (%) |
| Less than USD 528.49 | 281 | 91.83 |
| USD 528.49 - USD 669.91 | 21 | 6.87 |
| USD 670.12 - USD 839.02 | 4 | 1.30 |
| Total | 306 | 100.00 |

USD 528.49 to USD 669.91 and from USD 670.12 to USD 839.02, respectively.

### 3.1.2 Frequencies of transportation option

This study examined the transportation option used by respondents for their daily commute to work, as indicated in Table 4. According to the data in Table 4, the mode of transport chosen by the respondents for commuting to their workplace with the largest proportion is was motorbike, with 71.89% of the respondents selecting this option. Conversely, only 10.78% of respondents chose buses as their mode of transportation for commuting to work. This findings align with the Penang Institute report of 2014, where, a mere 11% of individuals in Penang utilized public transport between the peak hours of 7 a.m. to 9 a.m (Focus Malaysia, 2022). The survey indicates that a substantial proportion of employees in Penang exhibit a predilection for their own means of transportation rather than public transit when travelling to their workplaces. The low dependence on public transport in this state also elucidated by Chee and Fernandez (2013) in their study on the determinants of transportation mode selection in Penang, as they found that there was a prevailing negative impression of the public transportation system in the state. As a result, the majority of individuals opted to use their personal vehicles, specifically cars or motorcycles (Chee and Fernandez, 2013). Additionally, there are tourists that voice their complaints on the inadequate public transit services in this region (Panicker, 2022). Further, as the majority of respondents do not prefer public transport as their mode of transport to their workplace, this study employed factor analysis to determine the specific characteristics related to job accessibility that impact their transportation preferences.

### 3.1.3 Factor analysis on job accessibility

Table 5 displays the primary five components of job accessibility that were subjected to factor analysis in order to discover the influences on the selection of transport mode for commuting to the workplace among low-income workers in Penang Island. These considerations include Factor 1 (vehicle), which refers to the selection of a vehicle that makes commuting to the workplace easier. Factor 2 (road) indicates that the road network conditions between home and workplace are highly advantageous. Factor 3 (traffic) indicates that there is a scarcity of traffic congestion on the utilized roadways. Factor 4 (safety) emphasizes the infrequency of accidents on the commute to work. Factor 5 (economy) highlights that the selected mode of transport is the most financially efficient.

Initially, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were conducted on the five determinants of job accessibility, as shown in Table 6. The KMO test result for the influence of job accessibility on the choice of transport mode among low-income workers is 0.639. According to Table 6, the KMO value surpasses the minimum threshold of 0.50, suggesting that the sample size utilized is sufficient and does not suffer from multi-collinearity issues. Meanwhile, the Bartlett's test reveals that the *p*-value, which is equal to 0.000, is lower than the significance level. This result indicates that the correlation between components is strong enough to proceed with the next study. Thus, since the KMO value exceeds 0.5 and the Bartlett's test yields a significant result, it is appropriate to proceed with the factor analysis.

Table 7 displays the communalities value of the five components (refer to Table 5 for the descriptions of the factors in Table 7). Based on Table 7, the communalities for Factor 1, Factor 3, and Factor 4 exceed 0.5. This suggests that only

**Table 4** Types of transport mode for commuting to the workplace

| Type of vehicle | Percentage (%) |
|---|---|
| Motorcycle | 71.89 |
| Car | 17.33 |
| Bus | 10.78 |
| Total | 100.00 |

**Table 5** Factors of job accessibility

| Item | Factors |
|---|---|
| Factor 1 | Vehicle: The choice of vehicle for commuting to work facilitates travel |
| Factor 2 | Road: The road network conditions are quite favorable |
| Factor 3 | Traffic: Absence of traffic congestion |
| Factor 4 | Safety: Accidents hardly occur |
| Factor 5 | Economy: The most economical mode of transportation |

**Table 6** KMO and Bartlett's tests of factors influencing the job accessibility

| | | |
|---|---|---|
| Kaise-Meyer-Olkin measure of sampling adequacy | | 0.639 |
| Bartlett's test of sphericity | Approx. Chi-square | 111.802 |
| | df | 10 |
| | Sig. | 0.000 |

**Table 7** Communalities value

| Item | Initial | Extraction value |
|---|---|---|
| Factor 1 | 1.000 | 0.908 |
| Factor 2 | 1.000 | 0.239 |
| Factor 3 | 1.000 | 0.573 |
| Factor 4 | 1.000 | 0.584 |
| Factor 5 | 1.000 | 0.482 |

these three factors significantly impact the selection of transport mode for commuting to work among low-income workers. The communalities value typically represents the proportion of variance in each factor that can be accounted for by those factors.

Table 8 displays the eigenvalues and the corresponding variance percentages. The eigenvalue represents the amount of variance explained by each extracted factor in the factor analysis. According to Kaiser's criterion, only factors with an eigenvalue greater than 1.000 are considered meaningful and should be retained, while those with an eigenvalue below 1.000 are considered weak and should be excluded (Chua, 2006). This rule is widely used in exploratory factor analysis to determine the number of significant factors. Based on the results obtained, only two factors meet this criterion, with eigenvalues of 1.757 and 1.029, respectively. Together, these two factors account for 55.726% of the total variance explained, suggesting that they represent the underlying structure of the data well. The remaining three factors have eigenvalues below 1.000 (0.888, 0.758, and 0.567) and therefore were excluded from further interpretation.

The scree plot analysis further supports the decision to retain only two factors (refer to Fig. 2). The scree plot visually displays the eigenvalues associated with each factor in descending order and typically helps identify the "elbow point" – the point at which the curve levels off, indicating a natural cut-off for factor retention. In this case, the scree plot shows a clear inflection after the second factor, where the slope of the curve begins to flatten. This suggests that the first two factors contribute meaningfully to explaining the variance, while subsequent factors add little explanatory value. Thus, both the eigenvalue criterion and the visual inspection of the scree plot support the extraction of two main factors.

Table 9 displays the factor matrix that was rotated using the varimax rotation method. The results indicate that there is a correlation between the factor loading and the loading value for each of the factors of job accessibility, following the completion of varimax rotation. Consequently, two components were created based on the variables of job accessibility. Specifically, Factor 1 consists of three items, whereas Factor 2 consists of one item in each component.

After performing factor analysis, it can be determined that Factor 1 has the greatest influence on the choice of transport mode for low-income workers commuting to their workplace in Penang Island, Malaysia. Hence, the primary determinant for low-income workers in selecting their mode of transportation for commuting to work is the selection of the vehicle that enables the most convenient travel. This indicates that the respondents selected a type of vehicle for their work commute that facilitates a smooth ride, minimizes difficulties, incurs little expenses, and ensures efficient arrival at their workplace in a timely manner. The majority of respondents have selected motorcycles as their preferred mode of transportation for commuting to work. This choice is attributed to several advantages offered by motorcycles, including their cost-effectiveness compared to cars, their smaller parking space requirements, their lower fuel consumption resulting in reduced commuting costs, and their ability to easily navigate through heavy traffic congestion. The benefits of a motorbike include its cost-effectiveness compared to cars, convenient and affordable parking, superior maneuverability and speed, lower fuel consumption, more affordable maintenance, cheaper insurance premiums, quicker cleaning process, and outstanding performance (Direct Asia, 2017). Bowler (2023) states that motorbikes are lower in size compared to cars, which leads to a lesser impact on road systems and capacity. Concurrently, the majority of individuals believed that motorcycles emitted fewer carbon emissions compared to cars. Indeed, a motorbike releases around half the carbon emissions compared to a car (Hickman, 2006). However, when considering the emissions of greenhouse gases per capita per kilometer travelled, it is evident that commuting by bus is far more environmentally friendly than using cars or motorcycles. Hence, undoubtedly, public transit is typically the most favorable choice (Ritchie, 2023).

**Table 8** Eigenvalue, variance percentage and cumulative percentage

| Component | Initial eigenvalues | | | Extraction sums of squared loadings | | |
|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| Factor 1 | 1.757 | 35.139 | 35.139 | 1.757 | 35.139 | 35.139 |
| Factor 2 | 1.029 | 20.587 | 55.726 | 1.029 | 20.587 | 55.726 |
| Factor 3 | 0.888 | 17.758 | 73.484 | | | |
| Factor 4 | 0.758 | 15.168 | 88.651 | | | |
| Factor 5 | 0.567 | 11.349 | 100.000 | | | |

Extraction method: Principal component analysis

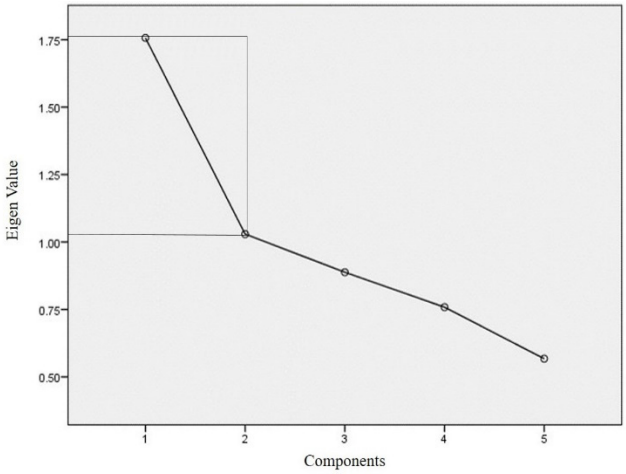


**Fig. 2** Eigenvalues based on the scree plot

**Table 9** Rotated factor matrix

| Item | Component | |
|---|---|---|
| | 1 | 2 |
| Factor 1 | | 0.952 |
| Factor 2 | | |
| Factor 3 | 0.753 | |
| Factor 4 | 0.740 | |
| Factor 5 | 0.634 | 0.282 |

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Rotation converged in 3 iterations

In Penang State, public buses are available as a form of public transportation. The state government has made several attempts to promote public buses, such as extending free rides and providing complimentary shuttle buses (Jia, 2022). Nevertheless, it is not the transit method of choice for the majority of individuals in this state. In their extensive analysis of bus services in Penang, Norhisham et al. (2021) discovered deficiencies in the performance of public buses, which serve as the primary mode of public transportation in the state of Penang. A multitude of travelers openly expressed their discontent, particularly with the insufficiency in meeting the demand for it (Norhisham, et al., 2022). Therefore, the findings of the study are consistent with the present circumstances, wherein people lack the bravery to opt for the bus as their means of transportation for commuting to work, primarily due to its inadequate support in facilitating their journey to work.

### 3.2 Qualitative findings

This study intends to investigate the motivation of individuals who choose to utilize the shuttle bus services provided by the Penang State government as their primary mode of transportation to work, in light of the fact that the public bus is not a favored means of travel. Interestingly, the participants who choose to commute to work by bus make up the least proportion within the study cohort. It is crucial to focus on influencing their perceptions when it comes to selecting shuttle bus services for travelling to work.

#### 3.2.1 Demographic characteristics

Table 10 displays the demographic attributes of the ten participants included in the qualitative portion of the study. Out of the responses for this in-depth interview, nine out of ten are women while only one was a man. There were six individuals employed as clerks, two individuals employed as accountant assistants, one individual employed as a children daycare worker, and one individual employed as a government servant. Generally, their age fell within the range of 30 to 49 years old. Their monthly salary varieds between USD 326.16 and USD 869.75. Each individual utilized the shuttle bus service offered by the Penang State government to travel to their place of employment.

Table 11 provides a concise explanation of the rationale behind using shuttle bus services for daily work transportation. Previously, the majority of responders, namely seven individuals, used their personal vehicles for commuting to their workplace. Meanwhile, one individual utilized e-hailing services, another relied on public bus transportation, while a third person utilized their own motorbike for getting to work. Each of them commenced utilizing the shuttle service bus approximately 5 to 11 years before the interview. The main reasons for choosing shuttle bus services among the 10 respondents are cost savings and convenience

**Table 10** Demographic characteristics

| Reference number | Age | Gender | Occupation | Income |
|---|---|---|---|---|
| R1 | 34 years old | Male | Accountant assistant | USD 869.75 |
| R2 | 39 years old | Female | Clerk | USD 543.60 |
| R3 | 30 years old | Female | Clerk | USD 521.85 |
| R4 | 43 years old | Female | Children daycare helper | USD 326.16 |
| R5 | 49 years old | Female | Clerk | USD 869.75 |
| R6 | 49 years old | Female | Clerk | USD 697.76 |
| R7 | 39 years old | Female | Accountant assistant | USD 695.80 |
| R8 | 34 years old | Female | Clerk | USD 580.13 |
| R9 | 36 years old | Female | Government servant | USD 652.32 |
| R10 | 48 years old | Female | Clerk | USD 697.76 |

in commuting, particularly due to avoiding the hassle of operating their own vehicles in heavy traffic. Regardless of whether the respondents had a car or motorcycle, they remained to use shuttle bus services because they found it to be more convenient and cost-effective.

### 3.2.2 Description of the factors influencing respondents' choice of shuttle bus services

An in-depth interview was conducted with 10 respondents who utilized shuttle bus services for their daily commute to gain comprehensive insights into the elements that influence their selection of shuttle bus services. The acquired data were categorized into different themes accordingly. The endeavor to achieve sustainable transportation is arguably the most arduous obstacle, necessitating the support and acceptance of the general population in order for operators to effectively provide low and zero-emission transportation (Vix Technology, 2023). Despite the current inadequacy and inefficiency of the public bus system in Penang State, the majority of its residents are eagerly anticipating the implementation of a reliable mass transit system (Sidek et al., 2020). This would greatly enhance the daily transportation experience by offering a high-quality and affordable public transportation option, similar to other cities that excel in providing sustainable urban mobility accessible to all segments of society (Sofea, 2015). The study revealed that participants were cognizant of sustainable transportation options and regarded utilizing shuttle bus services as the most favorable decision based on this specific assertion.

- Respondent 1 (R1): "Despite owning a personal vehicle, I will exclusively utilize it for trips to the market or shopping center. The shuttle bus enables me to save costs and also contributes to the reduction of pollution."
- Respondent 7 (R7): "In addition to lowering the number of automobiles on the roads, shuttle buses are very efficient in terms of cost and energy savings."

Utilizing a shuttle bus is generally a more economical option in contrast to purchasing multiple vehicles or depending on individual transportation. By centralizing the group into a singular vehicle, you can reduce expenditures on gasoline, parking charges, and tolls (Sutevski, 2023). Shuttle bus services are a proven cost-effective alternative to private vehicles, which might attract low-income workers due to the financial benefits it offers. Undoubtedly, the affordability will alter travel patterns, particularly if it is shown that dependence on personal vehicles for transportation can substantially contribute to living costs (Babinard, 2014). In this survey, despite the majority of respondents owning their own vehicles for commuting, they exhibited a preference for utilizing the shuttle bus services offered by the state government. Shuttle bus services serve as a valuable incentive for them, enabling them to save additional funds on transportation expenses and thereby alleviating their financial load. Respondents conveyed this circumstance through their statements in the in-depth interviews.

- Respondent 1 (R1): "Despite owning a personal vehicle, I will exclusively utilize it for trips to the market or shopping center. The shuttle bus enables me to save costs and also contributes to the reduction of pollution. I economize on fuel expenses."
- Respondent 3 (R3): "Due to budgetary limitations, I am unable to own my own automobile, hence I rely on using the bus for transportation. Using the bus is beneficial for me because I don't have to worry about the cost of fuel or paying for parking."
- Respondent 5 (R5): "I opt for the shuttle bus due to the exorbitant cost of driving my personal vehicle"

**Table 11** Background of choosing shuttle bus services for commuting to work

| Reference number | Previous transport mode | Duration of utilizing shuttle bus services | Reasons for opting for shuttle bus services |
|---|---|---|---|
| R1 | Car | 5 years | Sparing, cheap and efficient |
| R2 | Car | 11 years | Due to my refusal to operate a vehicle and search for parking |
| R3 | E-hailing services | 6 years | Did not possess any automobiles |
| R4 | Public bus | 11 years | Did not possess any automobiles |
| R5 | Car | 8 years | Save money for tolls and fuel, and also circumvent traffic congestion |
| R6 | Car | 8 years | Easier and to save money |
| R7 | Car | 9 years | Superior alternative than operating one's own vehicle |
| R8 | Car | 11 years | Conserve energy for operating a vehicle |
| R9 | Motorcycle | 8 years | Alleviate traffic congestion, decrease transportation expenses, and conserve energy |
| R10 | Car | 8 years | Easy to use and saving transportation cost |

- Respondent 6 (R6): "Using a shuttle bus allows me to save money, decrease traffic congestion, and avoid parking expenses."
- Respondent 7 (R7): "The cost savings are significant. I possess an automobile that I exclusively utilize for transporting my children to the desired crèche facility and for engaging in various other activities. However, I opt to utilize a shuttle bus due to its cost-saving benefits, including reduced fuel expenses, toll savings, and decreased car maintenance costs."
- Respondent 8 (R8): "It is reducing expenses."
- Respondent 9 (R9): "Utilizing the shuttle bus service allows me to minimize my commuting expenses. I found that utilizing the shuttle bus services allowed me to save a significant amount of money."
- Respondent 10 (R10): "The shuttle bus services enable me to economize on transportation and parking expenses."

While shuttle buses provide cost advantages to passengers, they also impose a drawback that passengers must endure: the unpredictability of punctuality. In their study, Borhan et al. (2019) investigated the appeal of public transport and found that the element of reliability significantly influences the promotion of public transport usage. Although shuttle bus services adhere to a predetermined timetable, they are inevitably susceptible to becoming ensnared in traffic congestion, resulting in delays to their arrival. Multiple respondents expressed dissatisfaction with the lack of punctuality in the shuttle bus services they utilize.

- Respondent 3 (R3): "Nevertheless, I must endure the waiting period for the bus to arrive. In the event of a traffic congestion, I am required to endure a lengthier period of waiting for the bus to arrive at the bus stop."
- Respondent 5 (R5): "However, in the event of a bus malfunction, there is a possibility that I may arrive late to my place of employment."
- Respondent 6 (R6): "However, the bus consistently gets caught in traffic congestion, resulting in a longer commute to my employment."
- Respondent 7 (R7): "I simply need to endure its lack of punctuality, as it occasionally deviates from the predetermined schedule."

The most problematic aspect is that clients of the shuttle bus service must exercise caution by waiting at the designated waiting spot at the allotted time. If not, they pose a risk of being left behind at the stop. This condition may necessitate them to seek alternative means of transportation at that time in order to secure their arrival at their workplace, or they may be compelled to be absent from work on that day. This situation was described by a respondent's statement:

- Respondent 8 (R8): "However, I am obligated to adhere to the bus timetable. Otherwise, I will be abandoned."

**4 Conclusion**

Selecting an appropriate form of transport plays a crucial role in shaping travel behavior within communities. The adoption of sustainable transport options can lead to sustainable mobility, which in turn addresses many of the persistent urban mobility challenges. Such a shift not only enhances environmental quality but also offers economic, urban, and health-related benefits.

This study revealed that the majority of respondents rely heavily on personal vehicles – particularly motorcycles – for commuting. Factor analysis identified that the availability of a vehicle for workplace travel is the most influential factor in promoting engagement among low-income workers. Personal vehicles offer convenience and autonomy, allowing users to travel on their own schedules without dependence on external timetables. However, this convenience comes at a cost, including fuel, parking fees, annual road taxes, and maintenance – expenses that disproportionately impact low-income individuals.

Interestingly, despite owning personal vehicles, many respondents expressed sensitivity to the costs associated with commuting. Consequently, some individuals – especially those with limited income – opt for more cost-effective alternatives such as public transportation. While shuttle buses are generally economical and eliminate the need for driving, users must tolerate drawbacks like occasional delays and inflexible schedules.

From the perspective of the Theory of Planned Behavior (TPB), travel behavior is influenced by attitudes, perceived behavioral control, and subjective norms. In this study, while individuals may hold positive attitudes toward sustainable or cost-effective transportation modes, their perceived behavioral control – such as access to reliable shuttle services – can limit actual behavior change. Furthermore, prevailing social norms around personal vehicle ownership and independence may reinforce car use, despite cost concerns.

When viewed through the lens of Mobility Transition Theory, which posits that societies transition from non-motorized to motorized transport as economic conditions improve – and potentially back to sustainable modes as awareness and policy support increase – the findings

suggest that low-income workers are at a transitional phase. While many have already acquired motorized vehicles (motorcycles), the rising costs and emerging awareness of more affordable public options indicate potential readiness for a shift toward sustainable mobility – provided the necessary infrastructure and policy support exist.

Therefore, to effectively promote sustainable travel behavior among economically disadvantaged groups, policymakers must focus on improving access to affordable, reliable, and convenient public transportation – particularly shuttle bus systems serving key employment hubs. Expansion of these services, combined with targeted subsidies or incentives, could increase perceived behavioral control and reduce the reliance on private vehicles.

Finally, while this study offers insights into the factors encouraging the adoption of different transport modes, it does not explore the barriers that deter individuals from choosing sustainable options. Future research should address this gap to develop a more comprehensive understanding and enable stronger generalizations.

**Acknowledgement**

The authors would like to acknowledge funding by the Ministry of Higher Education, Malaysia through the Fundamental Research Grant Scheme (FRGS/1/2022/SS07/USM/01/3) titled ACCESS - Equitable and Accessibility Framework for Transport and Landuse Planning in Pulau Pinang.

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