

RESEARCH ARTICLE

Characteristic of Micro-Mobility Devices' Users in Malaysia

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ABSTRACT - Introducing micro-mobility devices (MMD) such as bicycles and e-scooters as a transport option in Malaysia and the risk safety issues have attracted the attention of the government and enforcement agencies especially when they are cycling or riding on the road. Its uncontrolled use has made the government decision to ban the use of certain MMDs on the road with effect from the beginning of 2022. However, in order to support smart mobility, green and active mobility, the government is devising a mechanism to enable the use of MMDs in some areas. Therefore, this paper explores the characteristics and demographics of existing MMD users in Malaysia in order to assist the government give careful consideration to the safety of MMD users. The government must decide on the best ecosystem to implement the use of MMD through a safe control mechanism in terms of vehicles, infrastructure and users. To achieve an objective to assist in the decision-making process for the selection of appropriate countermeasures to promote the safety of MMD users, this study aims to assess and understand the characteristics of MMD users in Malaysia. This study only focused on existing MMD users. Throughout the online survey, a total of 371 respondents were involved in this study of which 277 were MMD users. This study also revealed that most MMD users in Malaysia are male, young (teenagers and adults) and have a fixed income.

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1.0 INTRODUCTION

Urban transportation is starting to use the term "micro-mobility" more frequently. Many think it's the next stage in revolutionizing the transportation industry. What is micro-mobility, and why are more cities promoting its use? In conjunction with encouraging a shift in the behaviour of drivers of private vehicles toward public transportation, promoting transit-oriented development (TOD) offers sustainable development near transit stations to encourage the usage of public transportation. The diameter of a typical TOD neighbourhood is between 400 and 800 metres, or about a quarter of a mile (5–10-minute walk). An important suggestion for enhancing first-last mile connectivity is to increase transport density since people are more likely to use high-frequency transit if it is close to where they live [1] [2].

Sustainable urban mobility involves developing a variety of fair and low-emission transportation solutions. Alternative means of connecting first and last-mile travels are necessary, along with the growth of public transit in cities [3]. Low Carbon Urban Mobility may effectively close these gaps and offer cities a more environmentally friendly transportation option. The community's awareness of and need for an economical method of transportation drives an increase in demand for comprehensive and integrated public transportation services which in turn can reduce traffic congested as well as road traffic crashes [4]. Encouraging people to use MMD is also in line with global Sustainable Development Goals to increase better well-being of citizens and sustainable cities and communities.

Nowadays the use of micro-mobility devices or MMDs such as bicycles, e-scooters, e-bicycles etc. (Figure 1) has gotten better and seen to have been used as a mode of transportation for example for work, i.e., panda walker, especially in urban areas as well as first and last mile mode for mobility.



Figure 1. Categories of micro-mobility device in Malaysia (Source: Ministry of Transport)

In Malaysia, MMD is defined as any vehicle designed to travel at or below 50km/h that is propelled by an internal combustion engine, an internal combustion engine and human power, or by a combination of electrical means, internal combustion engine and human power, is considered a micro-mobility vehicle [5]. However, observation found the safety awareness among MMD users is low. Most city inhabitants have already noticed the massive increase in shared bikes and scooters that have appeared throughout their area. This is partially due to the frequent hurried, chaotic rollouts of shared micro-mobility services. Since micro-mobility devices, unlike automotive airbags, do not provide protection, the previous study revealed several difficulties in the implementation of MMD use. Additionally, it needs effective legislation and collaboration between organizations and users [6].

Since the use of MMDs seems to be uncontrolled, in December 2021, the Malaysian Ministry of Transport announced a prohibition of the use of certain of MMDs use on the road. This includes Moped, Personal Mobility Devices (PMD), and Personal Mobility Aids (PMA) [5]. Meanwhile, PLANMalaysia is working to develop appropriate guidelines, to accommodate the needs of local councils to apply for approval to use MMD in their cities, in the development of infrastructure for MMD users. According to Pazzini et al., (2022), Europe an example is attempting to establish regulations for e-scooters in light of the risks involved with their use, but regrettably, there is no "agreement" or unification among the nations although some nations are regarded as a different category with their own set of legislation, the rules for bicycles have generally been followed [4].

In the meanwhile, the government must prioritize the security of MMDs users. In addition to infra development, the government and authorities also need to identify the best method of implementing the use of MMD. Malaysian Institute of Road Safety Research (MIROS) is also work closely with relevant stake holder to develop the Micro-mobility Implementation Road Map City Model and the Micro-mobility Safety Guidebook to assist control the safety aspects of the use of MMD. Safety issues and challenges with how MMD is used in cities are significant subjects that authorities must address. From an empirical view, this study sought to add to the value of knowledge by using data from surveys in relation to choices and interactions with other vulnerable road users. Additionally, identifying the characteristics may assist mobility planners in developing steps for better integrating MMD implementation in cities and local legislators in developing legislation and guidelines based on factual facts as well as to increase the safety of MMD users.

2.0 MATERIALS AND METHODS

The data for this study was obtained through an online survey. The questions were divided into several categories such as demographics, users and non-users and the type of MMD used. MMD in this study was grouped into 3:

- i) Personal mobility device (PMD): scooter and e-scooter:
 - Any type powered by human energy;
 - Any type powered by an electric source or an internal combustion engine (ICE) or both; has a throttle; or
 - Any type powered by an electric source or an internal combustion engine or both; usually built for the use of individuals with mobility problems or disabilities.
- ii) Bicycles:
 - Vehicles powered by human energy;
 - Has pedals for cycling purposes/acceleration and speed control;
 - Has a seat, handlebar, or limb/body movements;
 - Including unicycles.
- iii) Electric bicycle/e-bicycle/Power Assisted Bicycle (PAB):
 - Powered by an additional source of electricity to assist cycling/speed/acceleration;
 - Maximum speed limit 25 km/h with the help of electric power;
 - Will stop if stop pedaling;
 - Having pedals for cycling/acceleration/speed control; pedal mounting is either permanent or variable;
 - Has a seat and no throttle.
- iv) Moped:
 - Vehicles powered by an electric source, an internal combustion engine or both;
 - Having a throttle or other method for acceleration and speed control purposes.

Information or characteristics of the MMD used were also asked. Respondents were explained the definition and categories of micromobility vehicles through this questionnaire (Figure 2). Next, respondents were asked the question "Have you ever used any micromobility vehicle such as a bicycle/electric bicycle, moped or PMD/e-scooter?" to

determine the category of respondents as users or non-users of MMDs. A total 371 of respondents were involved in this study; grouped into users and non-user. Further findings will be explained in the chapter Result and Discussion.

PENGENALAN KENDERAAN MIKROMOBILITI

Berdasarkan kepada kesesuaian dasar, perundangan dan aplikasi diperingkat domestik, suatu kenderaan mikromobiliti mempunyai kelajuan maksimum 50 km/j dan diklasifikasikan kepada 3 kategori utama iaitu:

- A. Personal Mobility Device (PMD)
- B. Basikal/basikal elektrik
- C. Moped

Pernahkah anda pernah menggunakan sebarang kenderaan mikromobiliti seperti * basikal/basikal elektrik, moped atau PMD/e-skuter?

Ya

Tidak

Figure 2. Online survey form to categorize the respondents

Since this paper is to determine MMD users and due to the number of non-user categories those who participated in this survey were relatively low, this paper will only discuss the character of MMD users. Only respondents who are in the user category are evaluated. Each respondent was also allowed to choose more than one (1) MMD that they used. However, further research involving non-users of micromobility vehicles is recommended and should be done in the future.

3.0 RESULT AND DISCUSSION

This survey was conducted through online. The questionnaire was disseminated randomly within a month in year 2021, before the MMDs was prohibited from the road. A total of 371 respondents were involved in this survey and from that number, 277 (74.66%) of them stated they had used or having experience use MMD (Figure 3). In order to encourage the use of MMD, especially for first-mile and last-mile purposes for areas that cannot be reached by any public transport, as well as to reduce traffic congestion in the city centre, the characteristics of existing MMD users need to be studied. This is to see the space and need for improvement that is necessary and can be done by the government.

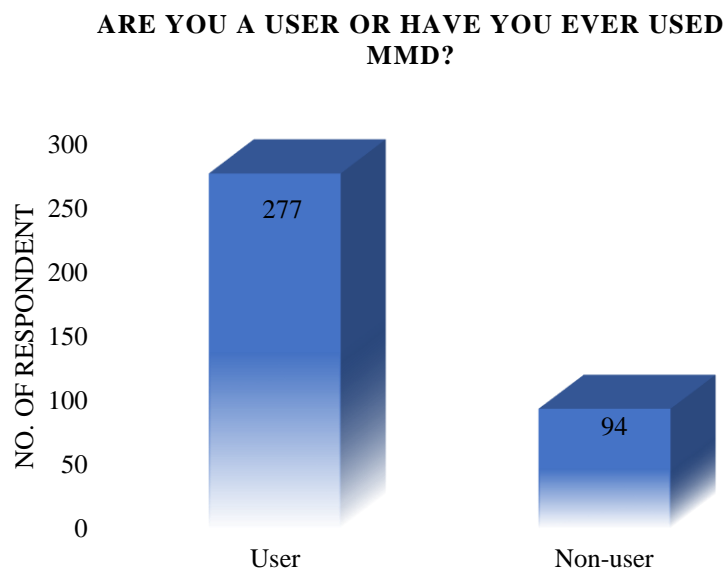


Figure 3. Micro-mobility user experience

Questions were also asked to those who have never used MMD and whether they plan to use or own MMD in the future. Surprisingly results found over 90% of them stated either 'yes' (43.62%) or 'maybe' (47.87%). This shows there have a demand for MMD use among the public (Figure 4) [4]. Prescient & Strategic Intelligence (2021) also foreseen an increase in the marketing of MMDs in Malaysia by 2030 due to several factors such as rising demand for micromobility services for first-mile and last-mile journeys, trends in technological advancement, cost-effective and convenient mobility [7]. Users of other common mobility services, such as e-hailing, will not use the service for shorter trips. Therefore, micromobility services can be offered. In addition, micromobility services are based on mobile applications where the Internet of Things (IoT) helps to optimize processes by enabling efficient methods of tracking and analyzing problems that may occur. Furthermore, national and global policies encourage adopting this type of mode of transport towards green and sustainable transport policies [2].

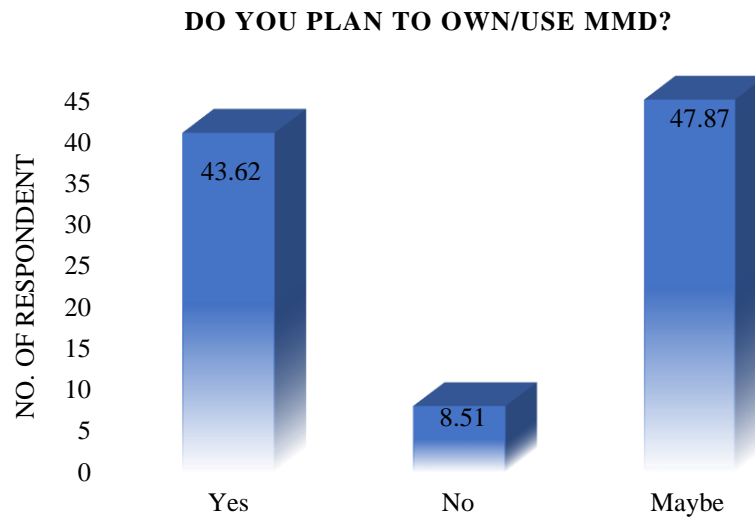


Figure 4. Micro-mobility acceptance among respondents

3.1 Users Demographic

Table 1 below explains the demographics and characteristics of MMD users in Malaysia. The risk of MMD users is evaluated through the respondent's accident history. More than 75% of the respondents have experience using PMDs which are scooters or e-scooters compared to bicycles/e-bicycles and mopeds, 50.54% and 11.19% respectively. The results of the study also show that most respondents have a high level of experience with the use of PMDs (scooter/e-scooter). This may be due to the rising development of this type of micromobility in the market in addition to the presence of shared PMD service operators such as Beam, Tryke and Oogyaa in cities. Furthermore, these devices are inexpensive, lightweight, minimal maintenance, eco-friendly, and manoeuvrable [8]. This study also revealed most of the respondents also familiar with the moped even though no experience riding it.

In addition, most PMD users consist of those aged 20-35 (46.89%), followed by those aged 36-34 (39.23%). The same trend is shown for moped users, 51.61% and 25.81% respectively. Meanwhile, the opposite trend is shown for bicycle/e-bicycle users when the results show that most of them are 36-45 years old (40.00%) followed by 20-35 years old (37.86%). This supports findings from Vincent B. (2022) and Nikolaus et. al. (2022) when it shows that these young people and the middle age group are quick to absorb (and accommodate) innovation [9] [10]. Due to their ease of use and fun factor, PMDs such as e-scooters are growing in popularity among teens in many cities in Malaysia. E-scooters are also now permitted in many universities, making it simpler than ever to get to classes and around campus. The price is also cheap and more practical than using public transport in campus. Another excellent option for running errands or commuting to work is an e-scooter [11].

As it was expected, the study found gender-based disparities in the usage of MMDs. According to Hall (2023), micromobility raises various gender-related concerns [12]. Though active and sustainable modes of transportation are beneficial for everybody, most research suggests that male use shared e-scooters and e-bicycles more frequently than female, implying that male gain more from micromobility. This study also clearly shows that male are more likely to use MMDs as compared with female when the result shows over 80% of them have experience using PMD, bicycle/e-bicycles, and moped [13] [14] [15] [16]. Safety is the main barrier for women to use these devices [14] [16]. This include infrastructure and urban structure.

Most of the MMD users are also those who have a fixed source of income, either government employees or private employees. Bank card payment is a feature of most mutual micromobility resources. This presents a challenge to users who might not have access to these services. It's important to consider suitable funding options, like prepaid cards and transit cards. For customers with modest incomes, these programmes may be unaffordable [17]. Thus, can be concluded users of MMDs are typically wealthy, educated, young men [18].

Table 1. Micromobility device user demographic

Variables	N = percentage (%)		
	PMD (Scooter/E-Scooter)	Bicycle/ E-Bicycle	Moped
Usage Experience:			
No and not familiar/unfamiliar with it	3.97	2.89	23.83
Nope. But know/familiar about it	20.58	46.57	64.98
Yes	75.45	50.54	11.19
Age Group			
<20 y/o	1.44	1.43	3.23
20 – 35 y/o	46.89	37.86	51.61
36 – 45 y/o	39.23	40.00	25.81
46 – 55 y/o	9.09	13.57	12.90
>55 y/o	3.35	7.14	6.45
Gender			
Male	88.52	82.14	83.87
Female	11.48	17.86	16.13
Occupation			
Self-Employed/Business	26.79	20.00	19.35
Private Staff/GLC/etc.	34.45	32.14	29.03
Student	5.74	3.57	6.45
Government Servants	30.14	38.57	41.94
Pensioners	0.96	2.86	0
Unemployed	1.91	2.86	3.23

3.2 MMD Ownership

Most respondents also stated that they are the owner of the MMD when asked about the ownership status of the MMD used (Table 2). This includes whether bought new, used, or obtained through gifts. This may be an extension of the ban on the use of MMDs on the road effective December 17, 2021, which makes shared devices difficult to find compared to buying their own. Payment using a bank card for most shared micromobility or ‘pay-as-you-go or subscription’ also provides barriers to users that may cause users to be more inclined to buy than rent as long as the selling price is also not too expensive. In addition, the device may be easily transported within the home or office due to its lightweight and foldable design [19].

Yet little is known about their service providers although there are several large operators such as Beam and Tryke that offer shared MMDs services in Malaysia. The result shows most of the shared bicycle/e-bicycles and moped users do not know their operators, 57.89% and 64.29% respectively. This scenario is seen to be able to give a bad impression in the event of any incident where the user does not know to who to channel information. Most cities have developed guidelines that require operators to display their information. The question of, whether is there still a failure of the operator or the attitude of users who do not care about the information before using the shared MMD service is another research question that needs to be explored.

In terms of maintenance, there is still less attention given by MMD owners when only 42-52% stated that their MMD is maintained once a month. While almost 30% of MMD owners never maintain their MMD even MMD do not need major maintenance. Certain cities may require device testing to ensure the seamless operation of these micromobility devices. There are still many cities and governments who are reluctant to promote micro-mobility devices due to serious safety issues.

A small vehicle speed such as PMD may be easily restricted, and in Europe, the e-scooter speed limit first started at 15.5mph (25kph). More recently, in Germany, the speed limit was reduced to 12.5mph (20kph), and the decision to do so was positively appreciated. In Australia, where it is legal to cycle on the sidewalk in some regions, e-scooters are now permitted, although with a 9mph (15kph) speed limit on the sidewalk and 15.5mph on the road or cycle lane (25kph). Around the world, as well as inside countries, there are regional variations in the laws governing speed and where to ride. While the Malaysian government puts the maximum PMD speed limit at 25km/h. While the results of the study found that most PMD users in Malaysia have PMD with speeds exceeding the limit (73.21%). A previous study found that one-third of injured riders reported that excessive PMD speed contributed to their injury [20].

To encourage the use of public transport, as well as increase ridership, in addition to solving the first-mile and last-mile problem, several types of MMD have been allowed to be brought into public transport [21]. This includes bicycles

and PMDs. However, the study shows the number is still low among MMD users in Malaysia. However, the study shows the number is still low among MMD users in Malaysia. The result shows only 30.14% of PMD users and 18.57% of bicycle/e-bicycles users have experienced bringing their MMD in public transport. This may be due to only some types of MMD such as folding bikes being allowed onboard and this restriction is an obstacle to encouraging users. In addition, some public transport services allow MMD to be onboard only during the off-peak period is also a barrier for users who want to use MMD as a substitute for private vehicles such as motorbikes and cars to get to work [22]. This is also against the national policy towards reducing traffic congestion and air pollution by encouraging the use of public transport.

Table 2. Micromobility device ownership

Variables	N = percentage (%)		
	PMD (Scooter/ E-Scooter)	Bicycle/ E-Bicycle	Moped
Ownership status:			
Self-Ownership			
Buy it	81.82	80.71	54.84
Gift	15.31	5.71	0.00
Rent	2.87	13.57	45.16
Do you know the service provider?			
No	0.00	57.89	64.29
Not sure	0.00	21.05	28.57
Yes	100.00	21.05	7.14
How often is your MMD maintained?			
Once a month	42.86	44.63	52.94
6 months once	22.66	24.79	11.76
Once a year	6.90	10.74	5.88
Never	27.59	19.83	29.41
Maximum Speed			
Not sure	0.96	1.43	3.23
<10km/h	1.91	8.57	3.23
10 – 25km/h	23.92	49.29	45.16
25 – 50km/h	50.72	35.71	29.03
>50km/h	22.49	5.00	19.35
Have you ever taken MMD into public transport?			
Yes	30.14	18.57	19.35
No	69.86	81.43	80.65

3.3 User Risk

MMD crashes can happen when cycling or riding in a variety of situations, and they can also entail collisions with other users like pedestrians and motor vehicles. Contrary to vehicle-involved crashes, there aren't nearly enough real-world MMD crash data available. In order to address these concerns, this study tried to elicit indirect information from sources including surveys. Although national statistics only record the number of accidents and injuries involving bicycles [23], the study found that there is a small number of MMD users have been involved in road accidents (Table 3). Yet even though the government did not enforce any rules or regulation against all MMD users, this issue needs to be taken seriously in ensuring the safety of MMD users and others. Some people think it's dangerous to utilise MMD because they don't provide protection, unlike airbags in a car. However, safety issues and occurrences may decrease if governments can establish appropriate rules and guidelines for the usage of micromobility.

To differentiate between minor and severe, this study classified severe injuries among those who were admitted to the ward. The result shows that most of the riders whose crashes led to slight or minor injuries. Most of them also stated that most accidents happen due to out-of-control or falling-off events and over 80% of the crashes occurred during the daytime.

Table 3. Micromobility device user risk

Variables	N = percentage (%)		
	PMD (Scooter/E-Scooter)	Bicycle/ E-Bicycle	Moped
Have you ever been involved in an accident while using MMD?			
Yes	8.13	12.86	19.35
No	91.87	87.14	80.65
What is the worst level of injury you have ever suffered?			
Severe (admitted to ward)	23.53	5.56	0.00
Minor injuries	70.59	72.22	100.00
Not injured	5.88	22.22	0.00
Type of crashes			
Involves motor vehicles (motorcycles, motorcars etc)	5.88	5.56	16.67
Involving objects or animals	5.88	22.22	0.00
Involves pedestrians	5.88	0.00	0.00
Out of control or falling-off	82.35	72.22	83.33
When did the accident happen?			
Nighttime (7pm – 6am)	17.65	16.67	16.67
Daytime (6am to 7pm)	82.35	83.33	83.33

4.0 CONCLUSION

Coordination between stakeholders and users is necessary for the implementation of micro-mobility plans, as well as related laws and regulations. Each relevant organization must work with others to understand the benefits and challenges, and to guarantee that rules and regulations are carried out efficiently, whether through providing recommendations for users or providing high-quality infrastructure for MMD. Communication between stakeholders can be difficult as a result. Cities need to overcome these barriers to properly deploy micromobility technology. This study shows that micromobility can be important for achieving the SDGs, especially SDG 3 (Good Health and Well-Being). Some research potentials are also listed. Through the data obtained through this online survey, we can understand and summarize the character of MMD users in Malaysia in order to help the government design an ecosystem for the use of safer micromobility. At the sampling, the guidelines that will be developed need to be examined so that the operation of micromobility vehicles in cities can achieve its objectives and not only be monopolized by certain groups. If the use of MMD is to support first-mile and last-mile solutions for areas that are limited by public transport, the technology in the use of shared micromobility should be more developed by not only limiting it to one type of payment. On the other hand, it should also be able to be enjoyed by the low-income user.

5.0 LIMITATION

In the nutshell, the sample in this study is not representing the vast majority of the Malaysian population, thus the findings should be interpreted with care and be perceived as an initial exploration of the MMDs user characteristics that may exist in Malaysia.

6.0 AUTHOR CONTRIBUTIONS

Azzuhana Roslan, Nora Sheda Mohd Zulkiffli and Rizati Hamidun: Conceptualization, Design, Draft manuscript preparation

Azzuhana Roslan, Nora Sheda Mohd Zulkiffli, Rizati Hamidun, Nur Zarifah Harun, Hawa Mohamed Jamil, Sharifah Allyana Syed Mohamed Rahim, Zarir Hafiz Zulkipli, Noor Kamaliah Alias, Nur Mustakiza Zakaria and Khairil Anwar Abu Kassim.: Data collection, Data analysis, Interpretation of results, Reviewing and Editing

All authors reviewed the results and approved the final version of the article.

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8.0 DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are included within the article. Data sharing is not applicable to this article.

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10.0 CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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