Stranger Micromobilities: A Video-based Exploration of Emerging Electric Micromobility Vehicles in Helsinki

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Abstract:

As urban mobility systems are undergoing transformations, there is a global trend of increasing diversity of battery-electric micromobility vehicles (EMVs). Such emerging unconventional vehicles include among others fat-tire e-scooters and electric unicycles. Despite this ongoing emergence, the current research has a notable gap in studying this phenomenon. With that gap in mind, this exploratory study investigates the growing presence of EMVs in Helsinki, Finland. Using 64 hours of observational video data collected from four key urban locations in 2021, this is the first study of the real-world usage of these emerging mobility technologies. The findings reveal a measurable presence of EMVs on city streets, contrasting with the dominant focus on standard e-scooters and e-bikes in most of recent research. In addition to quantifying the prevalence of EMVs relative to mainstream micromobility options, the study characterizes the types of vehicles observed, user demographics, and riding behaviors. While EMVs remain less common than conventional electric vehicles, their adoption in Helsinki is already significant. Riders tend to be highly skilled, with distinct patterns between delivery workers and general users. Initial insights suggest that EMV usage is driven by both recreational and practical motives. As an initial investigation, the study highlights the urgent need for further research into the emergence of novel and intermediary vehicles in urban mobility systems worldwide.

Keywords: micromobility; personal mobility vehicle; personal light electric vehicles; emerging mobility technology; intermediary vehicles.

1. Introduction

1.1. The emergence of electric micromobilities

The transformation of urban transportation systems should rely on a wide package of measures, among which the shift to more sustainable travel modes is key (Banister, 2008; Dia, 2019; Mladenović et al., 2021; Verma et al., 2023). Against this background, micromobilities (MMs) (Bahrami and Rigal, 2022) are emerging as potential alternatives for everyday urban travel (Abduljabbar et al., 2021; Oeschger et al., 2020). Although MMs refer to a broad concept that also includes non-motorized light vehicles such as conventional bikes, it comprises many types of light vehicles powered by an electric motor powered through the in-vehicle battery, which are usually referred to as electric Personal Mobility Vehicles (e-PMVs) (Boglietti et al., 2021). Most of the literature on electric micromobilities (e-MMs) has focused on the booming adoption of e-scooters and e-bikes, but less common e-PMVs (such as e-unicycles, e-hoverboards and e-skateboards) have already been identified as part of this emerging phenomenon (Abduljabbar et al., 2021; Bretones and Marquet, 2022; Leung and Burke, 2022; Zagorskas and Damidavičius, 2020). Some of these vehicles started as mere experimental models (see for example, (Ciocan et al., 2020; Qing Shan et al., 2008; Remedios and Manohar, 2015), and also associated to a broader trend of emerging intermediary vehicles (Bigo et al., 2022) but they are increasingly becoming commercially available.

The diversity of emerging e-PMVs is constantly increasing, as e-PMVs include a rapidly evolving range of light vehicles (International Transport Forum (ITF), 2020). Due to it being an emerging phenomenon, there is no wide agreement on how to define an e-PMV. E-PMVs are typically assumed to operate at a top speed of 45 km/h (Abduljabbar et al., 2021; International Transport Forum (ITF), 2020), although there is a certain controversy on whether to include light vehicles that reach speeds over 25 km/h (Bretones and Marquet, 2022). While the International Transport Forum defines MM as a group of vehicles characterized by having up to four wheels and weighing no more than 350 kg (International Transport Forum (ITF), 2020), the Society of Automotive Engineers describes e-PMVs as fully or partially powered vehicles of no more than 227 kg (SAE International, 2019). Besides such ambiguous technical features, e-PMVs can be grouped into several sub-categories based on a variety of aspects, such as self-balancing dynamics, center columns, seats, operable pedals, and floorboards (SAE International, 2019). Their maneuverability can serve as another classification factor (Zagorskas and Burinskiene, 2020). Moreover, they can also be classified in accordance with the business model that makes the vehicles available, as e-PMVs can be shared or privately owned (Abduljabbar et al., 2021; International Transport Forum (ITF), 2020; Oeschger et al., 2020).

Similar to what happens with the ambiguity on the technical features of e-PMVs, there is a lack of consensus on their naming. As an illustration, we can find differing names for e-PMVs as (Boglietti et al., 2021; Zagorskas and Burinskiene, 2020), such as Personal Mobility Devices (Che et al., 2020; Leung and Burke, 2022; Trauma Coordinators and Trauma Service Representatives et al., 2019) and Personal Transportation Devices (Fang et al., 2019). Moreover, there is no agreement on how to name the specific types of e-PMVs (see (Abduljabbar et al., 2021; Fang et al., 2019; International Transport Forum (ITF), 2020; Kim et al., 2018; SAE International, 2019; Trauma Coordinators and Trauma Service Representatives et al., 2019)). We acknowledge this complexity and note that we do not intend to set final definitions, while using Zagorskas and Burinskiene´s work as a starting point of reference (Zagorskas and Burinskiene, 2020). The wording used throughout the paper is an attempt to be coherent with the scope of this research.

As the emergence of e-PMVs has been characterized by a lack of stability in their features, there is a substantial uncertainty regarding their anticipated impacts. Much of the existing research has focused on the potential safety impact of riding e-PMVs. E-MMs have been found to increase the risk of severe injuries in comparison with traditional cycling, due to factors such as their higher speed (Trauma Coordinators and Trauma Service Representatives et al., 2019). Besides injuring e-PMV riders, an increase in the number of accidents could affect other groups, such as pedestrians (Kim et al., 2018). In addition to the direct safety impacts, previous studies have also evaluated indirect safety impacts (Xu et al., 2016; Zagorskas and Damidavičius, 2020). Beyond safety, according to Cook et al., an e-PMV would be categorized as an active mode only when physical exertion was sustained (Cook et al., 2022). Along with uncertain physical health impacts (Payne et al., 2025), we could anticipate some impacts on overall well-being through travel experience, similar to previous studies on skateboarding and scootering (Platt and Rybarczyk, 2020). Finally, regarding the wider issue of environmental sustainability, e-PMVs would generally rank somewhere in between active modes and internal-combustion modes (Shove et al., 2015).

1.2. The importance of revealed travel behavior

In order to further understand the emergence of e-PMVs, we must understand that this complex process does not merely consist of changes in technical or business model aspects, such as battery technology or sharing economy models. In fact, emergence ultimately is a process of change in the behavior of specific users and the wider society. Before technologies are stabilized and normalized as part of a mobility system, they undergo a phase of emergence in which both their technological and social elements are simultaneously co-created (Mladenović and Haavisto, 2021; Mladenović et al., 2022). This process of co-creation is often non-linear, unfolding over years and even decades, and relates to many uncertain impacts, as mentioned before. In the case of e-MM technologies, this partly relates to how people integrate them into their everyday travel habits, alongside with the travel experiences (Te Brömmelstroet et al., 2022). For example, the use of e-MM technologies is closely linked to the distances travelled (Abduljabbar et al., 2021) and the combinations of modes used (Oeschger et al., 2020), as well as the underlying motivations, such as environmental concern (Bretones and Marquet, 2022). Besides those, another key aspect to take into account is the revealed riding behavior at the street level. Having in mind the growing diversity of e-PMVs, it is important to understand the user profiles of their early adopters, as well as the different aspects of their riding behaviors in naturally occurring social situations.

1.3. Helsinki as a case city

The emergence and adoption of e-MM technologies is being driven by global forces but is also a context-dependent phenomenon. In general, the Nordic countries are global leaders in the adoption of various mobility innovations, such as e-MMs and electric cars (Aarhaug et al., 2023; Ingeborgrud and Ryghaug, 2019). In Finland in particular, context-dependence is reflected in several aspects. First, Finland has a rather liberal regulation in the domain of mobility services in general and e-MMs specifically (Sundqvist-Andberg et al., 2021; Ydersbond et al., 2020), with ongoing governance culture changes (Mladenović et al., 2020; Olin & Mladenović, 2025). Second, Finns are especially prone to adopting emerging technologies, as shown in previous research on their interest in adopting light electric vehicles (Hyvönen et al., 2016; Mesimäki & Lehtonen, 2023). Third, the emergence of urban mobility technologies intertwines with other factors, as Finland is undergoing a delayed urbanization and globalization process in comparison with its Nordic neighbors, reflected in transformation of its urban space (Mladenović and Stead, 2021), while maintaining the importance of traffic safety (Malin et al., 2020). Helsinki, the capital city, is a particularly relevant case due to additional factors, such as its urban density and population diversity (Jokinen et al., 2019; Tiitu et al., 2021), although they are still in average lower than most of European capitals. Furthermore, Helsinki is a multimodal city where walking has the highest modal share, while public transport and cycling have relatively high modal shares (Turja, 2022), with cycling being around 10%. Finally, Helsinki is a pathbreaking city aiming to achieve carbon neutrality by 2030 (Karhunmaa, 2019), which is reflected in its continuous mobility system transformation (Weckström et al., 2019). At the time of the study, no specific transport regulation has been in place regarding e-PMVs (Dibaj et al., 2025; Mladenović et al., 2022). Within the Helsinki context, previous studies have already identified new behavioral phenomena with e-scooter usage, such as group and multi-riding (Dibaj et al., 2024; Dibaj et al., 2025). All these aspects imply that Helsinki is an ideal case for studying the early stages of e-PMVs emergence.

1.4. Research aim and questions

This video-based study aims to understand the early adoption of emerging e-PMVs, specifically focusing on all the vehicles that are not e-scooters and e-bikes, with a case study of Helsinki. To this end, the study has the following research questions, relying on empirical analysis:

1. What are the types and proportions of e-PMVs?
2. What are the rider profiles using e-PMVs?
3. What are the e-PMVs riding practices?

2. Methodology

2.1. Methodological approach

To fulfill the aims of this exploratory study, a qualitative approach focusing on descriptive empirical data was adopted. While other methods such as surveys and interviews (see, for example (Bahrami and Rigal, 2022; Gibson et al., 2022)) can be useful for analyzing user preferences and stated behaviors (which could possibly not match the riders' actual behaviors), observational studies have proven insightful for scrutinizing mobility-related revealed behaviors. These naturally occurring social situations are commonly approached through video-based data collection and analysis (Knoblauch et al., 2014). In contrast to direct observations, video-based research offers the chance to conduct a very detailed scrutiny of social action and the use of technologies, as video data can be repeatedly examined (Heath et al., 2010). A popular option for video-based studies is ride-along methods (Ihlström et al., 2021; Lloyd, 2023). However, a ride-along method would limit the analysis to a narrow set of individual perspectives and imply challenges with participant recruitment. Instead, this research has opted for static cameras, previously shown to be useful for observing various cases of mobility-related interactions at the street level (Casello et al., 2017; Lyons et al., 2020; Phillips et al., 2011; Todd et al., 2019; Valero et al., 2020). The video analysis was not automated, since only a human coder would be capable of discerning the large set of nuances that the coding scheme required (see section 2.3).

The non-automated video analysis of revealed behaviors focused on three main aspects related to the three research questions. The first focus is on identifying types and proportions of EMVs. Second, the riders' profile analysis includes categories such as gender, age, ethnicity, and whether the rider was a delivery rider or not. Third, the analysis of riding practices includes the observation of riding gear, skills, riding surfaces and risky behaviors. Here, we differentiate between observations and riders. This is since some individual riders have been involved in more than on observation, as they have been recorded several times in the same location.

2.2. Video-data collection method

The selection process of video recording locations started with generating a larger set of possible sites within the city center based on land use and traffic volumes. From this larger set, ten locations were visited for further inspection. Beside land use and traffic volumes, each location was assessed in accordance with its types of infrastructures. In addition to these criteria, site visits helped in determining the suitability of camera heights and visual angles, which were intended to prevent potential vandalism and sun glare. From the inspected locations, four were finally selected for the research work, based on the balanced complementarity of their specific characteristics (see Figure

1). Viiskulma intersection was selected as a complex junction consisting of six roads, narrow sidewalks, cobblestone surface, and diverse land use. Ruoholahti underpass was chosen as a shared space for different user types while excluding passenger cars and larger motorized vehicles. Keskuskatu, in its crossing point with Aleksanterinkatu, was selected as a shared space including street furniture, terraces, streetcars and high volumes of pedestrians and light vehicles. Erottaja was chosen as a large junction including motorized traffic and discontinuous bike lanes and bike crosses.

With the intention of not affecting their spontaneous behaviors, the cameras were unobtrusively installed in such a way that they would not draw excessive attention from street users. A written privacy notice was attached to the camera poles after approval from the city. An example of a camera perspective can be found in Figure 2. The video recording was conducted in daylight and night-time conditions. Two Fridays were chosen as suitable days for recording, based on a combination of factors including higher traffic volumes during the weekends. Basic information on the dates, times and weather conditions that correspond to each video recording can be found in Table 1. The total length of the examined video recordings included 64 hours and 11 minutes. This amount of video material is comparatively nearly double than in similar reference studies (see (Lyons et al., 2020)).

Table 1: Context information. Source (weather data): World weather online, Helsinki historical weather

Location	**Date**	**Start time**	**End time**	**Temperatures**	**Rain**	**Sunrise**	**Sunset**
Viiskulma	29/10/2021	14:02	06:03	9 to 13 °C	No	08:36	17:32
Ruoholahti	29/10/2021	14:17	06:25	9 to 13 °C	No	08:36	17:32
Keskuskatu	29/10/2021	13:47	05:48	9 to 13 °C	No	08:36	17:32
Erottaja	05/11/2021	14:08	06:09	6 to 8 °C	Yes	07:54*	16:13*

*Summertime ended on October 31st. Sunrise and sunset times based on EEST and EET.

Figure 1: Four recording locations and camera perspectives in Helsinki city center (Background map (c) OpenStreetMap contributors)

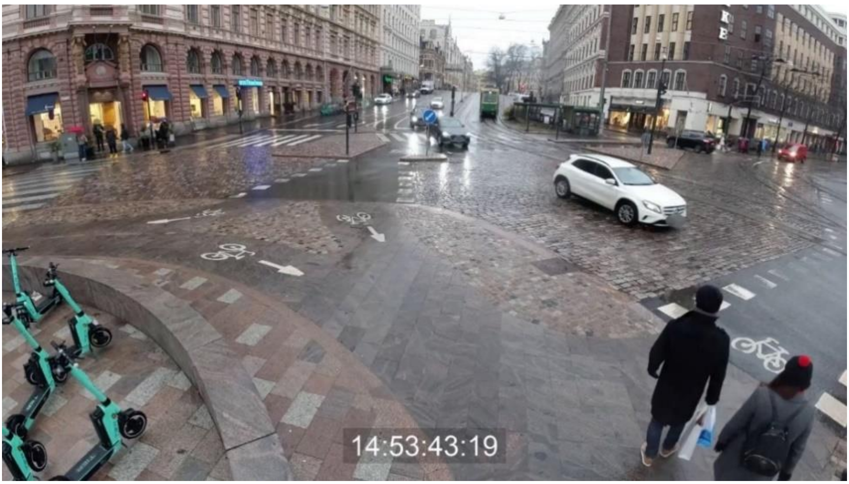


Figure 2: Example of a camera perspective in a recording location (Erottaja)

2.3. Video-coding process

The coding procedure involved multiple coders to ensure inter-coder reliability (Knoblauch et al., 2014). It was initially developed by a first coder for a testing location. The second coder independently coded the same location afterwards. Their two coding schemes were compared and re-evaluated with the help of two additional researchers. This resulted in a final procedure that was similarly applied to the four locations. As each recording site has specific features, such as infrastructural elements, certain parts of the coding procedure were re-adjusted for specific locations. The coding categories used can be found below in Table 2. The comments category was used for summary descriptions and additional comments, as well as reporting those cases in which a rider had appeared several times. On certain occasions, some details were not discernible due to different factors, such as the rider never facing the camera or being partially hidden by other vehicles. Those details were coded as unclear. It is relevant to remark that the coding process was intensely laborious, as every single time a rider was spotted, pausing and rewinding were necessary to make sure that all the coding categories were correctly identified. Although the video recordings were sometimes run faster for time efficiency reasons, they were not run much faster than real-time speed in order not to miss any observable rider. The estimated time needed for manually coding the video observations was approximately 250 hours.

Table 2: Example of coding categories (cont.)

Coding categories	**Brief explanations**
Observation number	An observation for each spotted EMV. When carrying a passenger (fat-tire e-scooters), coded as a single observation
EMV type	Type of vehicle identified Additional option for passengers of fat-tire e-scooters
Arrival time	Time from which the rider can be observed
Leaving time	Time from which the rider can no longer be observed
Duration of the observation	Difference between leaving time and arrival time

Table 2: Example of coding categories (cont.)

Coding categories	**Brief explanations**
Trajectory	Coding directions created for each location to code the riders´ trajectories
Riding on (surface types)	Sidewalk, road, bike lane, etc. coded in riding order over time
Inconsistent use of surfaces	Whether switching from one surface type to another without consistency
Way of crossing intersection	Multiple options, such as pedestrian crossing, road, bike crossing, etc.
Dismounting to cross intersection	Whether dismounting from the vehicle before crossing
Checking sides to cross the intersection	Whether turning head to check traffic circumstances before crossing
Eating, smoking, drinking	Whether eating, drinking or smoking while riding
Headphones, mobile phone	Multiple options, such as whether a mobile phone was attached to the handlebar
Perceived gender	Not always clear due to different factors such as helmet use
Perceived age	Coding options: child, teenager (13 to 17), young adult (18 to early 30s), middle-aged (late 30s to early 50s), old (late 50s and over), unclear
Perceived ethnicity	Coding options: Asian, Black, Hispanic, White, others, unclear
Flock riding	Several riders riding together (involving several vehicles)
Delivery worker	When carrying a delivery bag and wearing work clothing
Riding problems	Multiple options, such as lost control over the vehicle, no night-time light, etc.
Carried gear	Multiple options, such as backpacks, handbags, bags on the handlebar, etc.
Protective gear	Mainly helmets, but also other options such as reflective vests or knee pads
Perceived speed	Whether perceived as riding relatively fast or slowly, when not braking
Speed reduction at the intersection	Coding options: No reduction, slight reduction, big reduction, stops, unclear
Weaving	When perceived as riding in a playful way, not in straight lines
Doing tricks	When performing playful tricks, such as wheelies
Distance with pedestrians	When perceived as keeping an unsafe distance from the pedestrians

Table 2: Example of coding categories (cont.)

Coding categories	Brief explanations
One-hand driving	When driving using only one hand at some point (fat-tire e-scooters)
Parking vehicle	When the rider parks, determining whether responsibly or not
Turning lights, hand turning signals	When the rider uses turning lights and/or performs hand turning signals
Red light	Not stopping at the red traffic light
Crashing, almost crashing	When crashing or almost crashing with pedestrians, cars, bikes, etc.
Drunk, intoxicated	When the rider is perceived as apparently drunk or intoxicated
Perceived riding skills	Whether perceived as an experienced rider or a beginner
Comments	Open section for additional comments and descriptions

3. Findings

3.1. Types and proportions of EMVs

In total, five types of EMVs were identified: fat-tire e-scooter, e-unicycle, one-wheel hoverboard, e-skateboard, and off-road e-skateboard, as illustrated in Table 3. Among the identified e-PMV riders, over half rode fat-tire e-scooters, making them the most common type of EMV. Notably, two of these drivers travelled with a passenger. Electric unicycles stood as the second most frequently observed EMV, accounting for over half of the number of fat-tire e-scooters. In contrast, the other types of EMVs were much less numerous. As explained before, certain riders were spotted more than once, thus making the total number of observations (n=101) greater than the total number of riders (n=78) (see Table 4). Moreover, it is relevant to note that in three observations, two riders were identified at the same time, as driver and passenger were part of a single observation.

Table 3: Identified EMVs in Helsinki

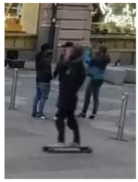
EMV types	Fat-tire e-scooter	E-unicycle	One-wheel hoverboard	E-skate-board	Off-road e-skateboard
Exam-ples of obser-vations					

Table 4: Number and proportion of observations and riders per vehicle type

EMV types	Fat-tire e-scooter	Fat-tire e-scooter (pass.)	E-uni-cycle	One-wheel hover-board	E-skate-board	Off-road e-skate-board	Total
Observations	57	3*	37	2	2	3	101
Proportion	56.4%	3.0%*	36.6%	2.0%	2.0%	3.0%	100%
Riders	44	2	27	2	1	2	78
Proportion	56.4%	2,6%	34.6%	2.6%	1.3%	2.6%	100%

*Coded as single observation (fat-tire e-scooters) when carrying a passenger (pass.)

3.2. Riders' profiles

In terms of the chosen EMVs for riding, there was a clear contrast between delivery and non-delivery riders (see Table 5). Delivery riders only rode fat-tire e-scooters (around six in every ten riders) and e-unicycles (around four in every ten riders). In contrast, non-delivery riders rode a wider variety of EMVs, albeit they too generally rode fat-tire e-scooters and e-unicycles, as shown in Table 5.

Table 5: Number and proportion of riders per EMV (delivery vs. non-delivery riders)

EMV types	Fat-tire e-scooter	Fat-tire e-scooter (pass.)	E-uni-cycle	One-wheel hover-board	E-skate-board	Off-road e-skate-board	Total
Delivery rid-ers	35	-	22	-	-	-	57
Proportion	61,4%	-	38,6%	-	-	-	100%
Non-delivery riders	9	2	5	2	1	2	21
Proportion	42,9%	9,5%	23,8%	9,5%	4,8%	9,5%	100%

Regarding gender, a contrast between delivery riders and non-delivery riders was found. According to Table 6, while all observed delivery riders were males, this was not the case for non-delivery riders. Among those cases in which gender was clearly recognizable, three corresponded to females (i.e., a fat-tire e-scooter rider, a passenger and an e-skateboard rider). In any case, despite non-delivery EMV ridership not being a male-only phenomenon, a substantial majority of observed non-delivery riders were males.

Table 6: Gender and delivery distribution of EMV riders in Helsinki

EMV types	**Fat-tire e-scooter**	**Fat-tire e-scooter (pass.)**	**E-uni-cycle**	**One-wheel hover-board**	**E-skate-board**	**Off-road e-skate-board**	**Total**
Male delivery riders	25 (65.8%)	-	13 (34.2%)	-	-	-	38
Female delivery riders	-	-	-	-	-	-	-
Male non-delivery riders	6 (46.2%)	-	4 (30.8%)	1 (7.7%)	-	2 (15.4%)	13
Female non-delivery riders	1 (33.3%)	1 (33.3%)	-	-	1 (33.3%)	-	3
Total	32 (59.3%)	1 (1.9%)	17 (31.5%)	1 (1.9%)	1 (1.9%)	2 (3.7%)	54

Concerning perceived age, a two-fold pattern was found (see Figure 3). On one hand, most of the delivery riders (DR in Figure 3) were perceived as middle-aged males, while a majority of the non-delivery riders (NDR in Figure 3) were identified as young (excluding unclear cases). On the other hand, the age of riders also varied depending on the type of device chosen: All those perceived as middle-aged rode fat-tire e-scooters, while most of those identified as young rode other types of EMV, as shown in Figure 3. In fact, all young non-delivery riders rode other types of EMVs. Only one rider was perceived as old (an old female riding a fat-tire e-scooter). All the riders apparently were adults, as no child or teenager rider was identified.

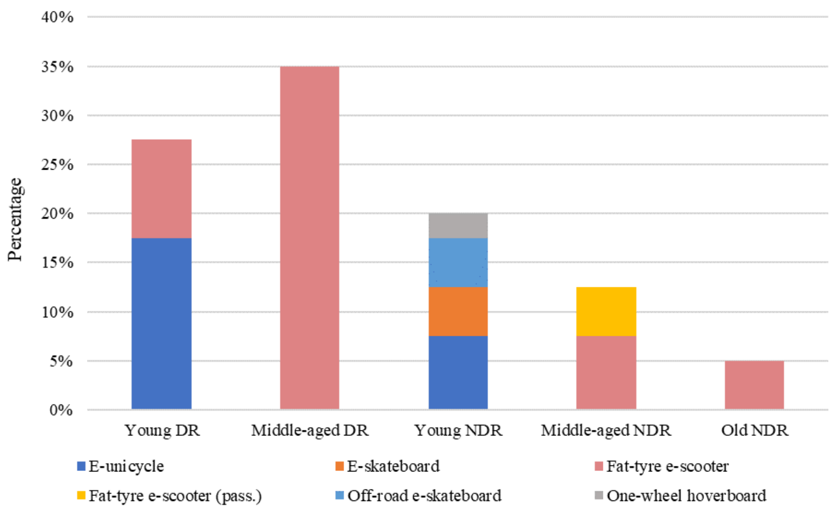


Figure 3: Proportion of age and delivery distribution of EMV riders in Helsinki

Finally, another aspect to mention is the difference between delivery and non-delivery riders in terms of perceived ethnic background. While twelve out of twelve delivery riders (as unclear cases excluded) seemed to pertain to ethnic minorities (Black and Asian, apparently), a great majority of the identified non-delivery riders (eight out of ten, as unclear cases excluded) appeared to be of White ethnicity. The two exceptions corresponded to fat-tire e-scooter riders of apparent ethnic-minority origin. All the non-delivery riders who rode EMVs other than fat-tire e-scooters apparently were of White ethnic origin.

3.3. Riding practices

Riding gear

With reference to safety-related riding gear, there was a remarkable difference between the two most common groups of riders: Riding fat-tire e-scooters involved much less helmet use than riding e-unicycles. While in over 90% of the fat-tire e-scooter observations the rider did not wear a helmet (with only five exceptions), the rider wore a helmet in over 80% of the e-unicycle observations (see Figure 4). A helmet was worn in the few off-road e-skateboard and one-wheel hoverboard observations, but not in the case of the e-skateboard. An additional but uncommon safety item was identified in four observations, as an e-unicycle rider (spotted twice) and an e-skateboard rider (spotted twice) wore protective knee pads.

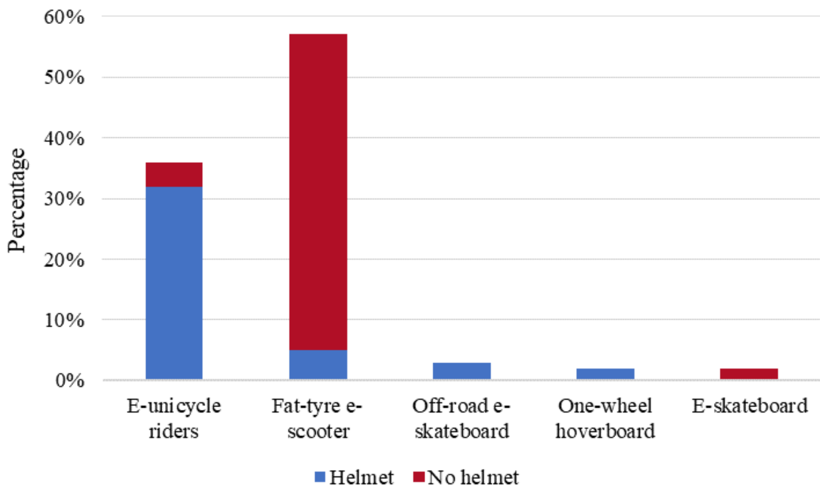


Figure 4: Percentage of helmet usage among EMV riders

Regarding their carried gear, only in nine occasions the riders did not carry any item. In most of the observations (71.1%), the rider only carried a backpack. This was by far the most common practice, although several other combinations were identified, as certain riders carried shoulder bags or bags in other positions such as attached to the handlebar or in one hand. All delivery riders carried a big delivery bag, most of them on their backs. Interestingly, in five occasions the delivery bag was placed in between the driver's legs. Whether this could imply additional safety-related risks is not clear to us. In nearly half of the non-delivery observations (48.1%), the rider carried a backpack. In a few additional cases, they carried other types of bags.

Skills and riding surfaces

The perceived level of riding skills was in all cases high. Apparently, they all were experienced riders who had no difficulty with handling their electric-powered devices and simultaneously dealing with traffic. Perceived speed and deceleration, as well as checking sides at the intersection, did not provide valuable information, as these variables fluctuated with intermittent traffic conditions. In a similar way to cyclists, the three fat-tire e-scooter riders who signaled a turn did so by performing hand turning signals, despite these e-PMVs having turning lights. An e-unicycle rider also performed hand turning signals at an intersection.

Concerning riding surfaces, most of the riders rode on bike lanes, roads and a pedestrian street where light vehicles are allowed. Nevertheless, in nearly one in every five observations (17.8%), the riding was on sidewalks, which is not allowed in Finland. In addition to that, in over one in every five observations (20.8%), the rider made inconsistent use of the riding surfaces, meaning that they switched from one surface type to another without a clear reason related to the built environment or traffic conditions. For example, this would include riders who switched from a bike lane to a road, despite having the option of continuing riding on a bike lane that did not have onward traffic.

Risky and non-cooperative behaviors

A rather usual behavior that could potentially have safety-related implications is using a mobile phone while riding. Figure 5 depicts the Percentage of phone usage among EMV riders per vehicle type. Based on this figure, a clear difference between the two most common EMV was identified: While no fat-tire e-scooter rider checked the phone while riding, in over one third of their observations (37.8%) e-unicycle riders checked the phone at some point. The use of headphones was identified too, but only in two observations (e-skateboard rider).

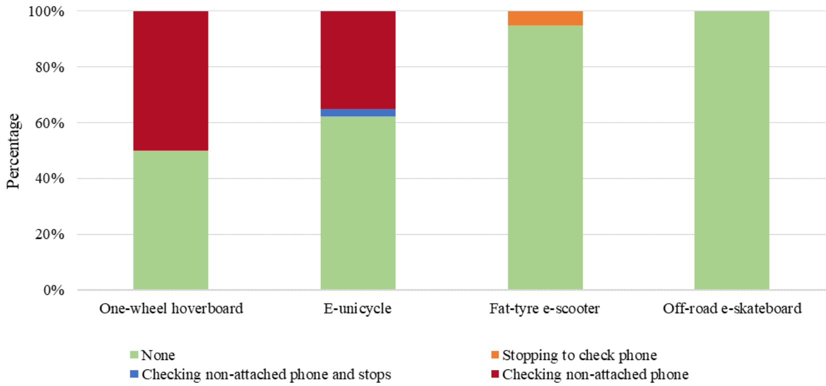


Figure 5: Percentage of phone usage among EMV riders per vehicle type

Certain minority non-cooperative behaviors that could potentially lead to serious safety-related issues were detected. Not keeping enough distance from pedestrians was identified in seven observations (6.9%). A couple of these occasions resulted in a near-crash event caused by e-unicycle riders. Another safety-related issue that was detected is counter-flow riding. Riding against the traffic flow was observed in four occasions (4%). The risk of counter-flow riding varies depending on the riding infrastructure: Two fat-tire e-scooter riders rode against the traffic flow on bike lanes, while another two riders (an e-unicycle rider and a one-wheel-hoverboard rider) did so on car-dominated roads, which implies the severe risk of cars and heavy vehicles such as buses coming ahead. Riding at night without proper vehicle lighting was identified as another safety concern in certain instances. This was observed in nine occasions (8.9%), five of them corresponding to e-unicycles and the remaining four to fat-tire e-scooters.

Finally, it is also important to mention certain aspects that were found not to be present on any occasion. No flock or tandem riding was observed at all: neither flocks of riders (only a couple of e-unicycle riders were spotted riding together in two occasions) nor more than one person riding a single vehicle (with the exception of fat-tire e-scooters, which are fit to carry a passenger). No rider seemed to be drunk or under the influence of toxic substances. Also, no rider performed any kind of trick (such as wheelies).

4. Discussion and conclusion

4.1. Discussion of findings

This research has contributed to empirically demonstrate that moving around with EMV is not a mere futuristic vision of urban mobility but a phenomenon that is already starting to take shape. The findings have shown that a range of EMVs is being used in the streets of Helsinki. According to this analysis, at least five different types of EMVs are being ridden in the Finnish capital. This revealed adoption is in line with a past survey on stated interest in adopting light electric vehicles among the Finnish population (Hyvönen et al., 2016). Two types of EMVs were identified as by far the most commonly used ones: fat-tire e-scooters and e-unicycles. Similarly to previous research in the Australian context (Leung and Burke, 2022), devices such as privately-owned e-unicycles and e-skateboards were found to be less common than regular e-scooters. This difference could be even greater if shared e-scooters were taken into account, as several e-scooter operators are active in Helsinki. Nonetheless, it is clear that EMVs are emerging on the streets, not in negligible numbers, albeit still relatively uncommon especially when compared to the modal share of cycling. Moreover, in comparison, a total count of e-scooter riders observed in the same locations was over 1300, which indicates a tenfold difference in the adoption scale of these emerging technologies.

Regarding the two main profile groups, while delivery riders only rode fat-tire e-scooters and e-unicycles, non-delivery riders also used other types of EMVs. This probably means that these other vehicles, such as e-skateboards and one-wheel hoverboards, are seen as less suitable for gig work. According to the findings, there is a profile gap between delivery and non-delivery riders using EMVs in Helsinki. Profile features such as gender, age, and ethnic origin were found to vary considerably when comparing these two groups of riders. It is important to note that no observations identified a child or teenage rider.

Delivery riders were generally found to be male, middle-aged, and of ethnic minority origin. Although certain researchers have contrarily suggested that delivery gig work is dominated by White working-class women (Milkman et al., 2021), these findings are consistent with much of the literature suggesting that platform-economy workforces tend to be disproportionately made of migrants and ethnic minorities (Gebrial, 2024), including also in the Nordic context (Newlands, 2024).

In contrast, non-delivery riding proved not to be a male-only phenomenon. Moreover, non-delivery riders tended to be younger adults of White ethnic origin, which clearly relates to the different use purposes of this group. The fact that around two-thirds of the non-delivery riders carried backpacks or other types of bags implies that non-delivery riders do not generally aim at riding for fun exclusively. Instead, EMVs might be used as part of everyday traveling, such as commuting or going to leisure activities. Similar to e-scootering, which has been interpreted as both playful and utilitarian (Dibaj et al., 2021; Wallius et al., 2022), we could infer a utilitarian component instead of undirected travel for the fun of the ride (Hook et al., 2022).

Regarding skills and usual riding behaviors, EMV ridership seems to be pioneered by generally skillful and experienced riders, who usually ride in a suitable way given the available infrastructure. For example, as two riders rode against the traffic flow on the road, this type of risky behavior does not seem to be frequent. Moreover, drunk and tandem riding were not found to be present in the observation set, given the limits of the observation method. This finding might partly relate to the characteristics of the vehicles themselves. E-scooters, with their standing platforms, afford tandem riding, as observed in previous research (Currans et al., 2022; Haworth and Schramm, 2019; Siebert et al., 2021; Todd et al., 2019). On the contrary, EMVs such as e-unicycles are not fit for this purpose, thus making them less prone to enable this kind of riding misbehavior.

Besides the generally high level of riding skills, several other aspects might entail associated risks and inconvenience for other street users. For example, problems with both pedestrians and other vehicles could potentially arise from the fact that in over one in every five observations the rider made inconsistent use of the riding surfaces, thus making it difficult for the rest of the street users to predict the rider's behavior. Another example is riding on sidewalks, which was performed in nearly one in every five occasions. Not keeping enough distance from pedestrians was not a common issue, but it is important to highlight two near-crash situations, which clearly indicate potential safety-related problems, as with other micromobility devices (Kim et al., 2018; Trauma Coordinators and Trauma Service Representatives et al., 2019).

Concerning the two most common EMVs (fat-tire e-scooters and e-unicycles), further safety-related issues were identified related to helmet use and phone use while riding, similar to previous research on e-scooters (Huemer et al., 2022; Useche et al., 2022). While helmet use was much more frequent among e-unicycle riders, they used the phone while riding far more often than fat-tire e-scooter riders. We could assume that the lack of need to use their hands to handle the vehicle makes electric-unicycle riders feel relatively risk-free when checking their phones. However, despite their apparent high skills, this behavior could lead to miscalculations and potential safety risks.

4.2. Policy and governance implications

This early video-based research points to the viability of successfully integrating these vehicles into daily urban mobility in the Finnish context. Taking a responsible assumption that the EMV ridership is anticipated to grow in the coming years, it is clear that active steering by relevant governance bodies will be needed if the emergence of e-MMs is to become an important component of the mobility system transformation. Even if we are witnessing some negative implications, the positive side is that new technologies and social behaviors typically co-evolve for long periods until they become stable (Mladenović et al., 2022). This gives us time for coordinated action across different governance levels and for the development of the governance practices themselves. On the Finnish municipal level, and in the short term, governance development should lead to improvements in street design and parking rules, as they primarily fall under the purview of cities. As seen in this research, the interactions between different types of users in the urban space can potentially lead to conflicts, and accounting for these new users when (re-)designing cities will be needed. On the national level, at the time of the study, Finland has been lagging in the regulation of e-MMs in contrast to other Nordic countries. Despite the ongoing legislative efforts regarding drunk riding, some potential aspects to consider include helmet use, vehicle licenses, and rider insurance, as well as the particular governance of delivery services. These actions should also be taken as soon as possible, without waiting for EU or international regulation and standards.

4.3. Limitations and future research suggestions

Despite offering a valuable empirical analysis of its early adoption in the streets of Helsinki, universal and definitive conclusions on the emergence of EMVs should not be made from this early research work. More empirical data and analysis of this new phenomenon are needed for internal and external validity, as the findings are influenced by specific elements such as the recording context within the city center and the relatively limited sample size. Additionally, we must acknowledge that, perhaps, despite our intensely laborious non-automated coding process, we might have missed or misinterpreted certain details.

The use of EMV is a recent and small-scale phenomenon that is still far from conceptual closure and social stabilization, so there is a plethora of potential research pathways ahead of us. While this early study suggests that the use of EMVs in Helsinki is being pioneered by reasonably well-behaving riders whose motivations are both utilitarian and playful, surveys and other methods should put these findings to the test. They should be complemented by more research on how certain factors affect ridership, such as weather conditions, which have been shown to influence e-scootering (Kimpton et al., 2022; Noland, 2021). Another suggestion is assessing comparatively the safety risks associated with different light electric vehicles and with cycling. The evaluation of substitution patterns, together with safety and health impacts, could also help the authorities in taking informed decisions on why and how to promote EMV ridership. Finally, a wider variety of case studies from different parts of the world would offer an international perspective of this global but context-dependent phenomenon (Ryghaug et al., 2023).

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