Expert study: ‘Safety and environmental aspects of the use of Personal Mobility Devices’

Final Report, September 2022

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Final Report

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VERSION HISTORY

Reference Number	Issued Date	Revision
Interim report 1	29 April 2022	First issue
Draft Final Report	July 2022	First issue
Recommendations	August 2022	First Issue
Final Report	September 2022	Second Issue

EXECUTIVE SUMMARY

Background

- Ricardo Energy & Environment have prepared this expert study considering the safety and environmental impacts of Personal Mobility Devices (PMDs) on behalf of FIA European Bureau.
- The main aim of the study was to gain a deeper understanding of the implications of the growing number of PMDs on urban roads, from both a regulatory and technical perspective, with a focus on understanding the safety and environmental aspects of the use.
- The scope of the study included electric bicycles, electric scooters, self-balancing machines and cargo bicycles.

Approach

- A detailed review of existing literature and evidence, primarily from Europe, was undertaken, considering the regulatory, safety and environmental aspects of PMD use. This information was used in the development of an excel-based evidence database.
- Three city case studies were developed (based on desk-research), exploring the use of PMDs. These were for Paris (FR), Madrid (ES) and Copenhagen (DK).
- A consumer survey was undertaken, yielding 2,420 respondents across the three case study cities, to gain an understanding of consumer awareness regarding PMD use and potential issues.
- Policy recommendations were developed, taking into consideration the analysis from the evidence review, case studies and consumer survey.

Findings

- There has been a rapid increase in the availability and use of PMDs in Europe, including e-scooters and e-bikes (private and shared).
- The ‘Machinery Directive’ (Directive 2006/42/EC) details essential health and safety requirements, approval and certification methods applied to ‘machinery’ offered for sale in the EU, which includes non-type-approved PMDs such as Electrically Power Assisted Cycles (**EPAC**) – Classic e-bike (‘pedelec’) with speeds up to 25 km/h and power cut off at 250 watts. CEN Standards are also available for EPACs. E-scooters are not included in this legislation.
- However, there are no automatic rights for PMDs that are in this category to be placed into service and used on roads. They are reliant on national regulations in each Member State to be used on public roads/space etc. and there is no common approach across EU Member States.

EXECUTIVE SUMMARY

Findings cont.

- PMD use has the potential to contribute to local sustainability objectives where they replace private car trips (i.e., mode shift), including:
  - Reduced car dependency (addressing traffic, congestion, noise, delays, stress);
  - Improvements in air quality and reduction in transport's contribution to carbon emissions and climate change; and
  - Increased accessibility/mobility in urban areas (providing a ‘last-mile’ solution, widening the catchment area of public transport, and enabling physical activity benefits).
- The review of the evidence and feedback from consumers revealed that there is still some doubt relating to the achievement of benefits through the promotion of PMD use in Europe’s towns and cities:
  - Safety concerns have been highlighted relating to interactions between PMDs and other road users and pedestrians - in particular for e-scooters:
    - Causes of e-scooter accidents include use of alcohol/drugs, disregard of traffic rules, excessive speed, carelessness / distraction, inexperienced users, conflicts over space, road surface/maintenance, and parking of e-scooters (causing injury to others).
    - Causes of e-bike accidents often relate to mounting/dismounting (battery weight/weight distribution), speed, disregard of traffic rules, and age of riders (typically more elderly).
    - Little evidence is available regarding the safety of cargo bikes – data related to bicycles/e-bikes tend to be used as a proxy. However, it is suggested that the increased size of cargo bikes and limited dedicated road space could contribute towards safety concerns.

EXECUTIVE SUMMARY

Findings cont.

- There is a lack of specific or harmonised ‘Micromobility’ legislation, both at European and national level. Enforcement of existing rules is also often an issue. Both factors contribute towards poor safety – both real and perceived.
- Further research, based on consistently collected accident data and statistics, is required in order to fully understand the potential safety implications of PMD use and to inform the development of effective safety legislation and rules for use.
  - This includes clearly defining ‘Micromobility’ and differentiating between PMDs in the accident data and statistics collected by Member States.
- It is acknowledged that there is potential for environmental and other benefits to arise from mode shift from personal cars to PMDs.
  - However, further research is required to fully understand PMDs contribution to sustainability goals, including whether the shift is coming from other sustainable modes of transport (e.g., public transport or active mobility) or if new trips are being generated.
- Finally, whilst studies are emerging considering the lifecycle impacts of PMDs, including material use and manufacturing, impacts during the use phase, and end of life, further research is also required to more clearly understand how PMDs compare to other modes of transport.

EXECUTIVE SUMMARY

Recommendations

- In order to maximise the benefits of PMD use, the following will be of key importance:
  - More clearly defined ‘Micromobility’ modes – common definitions are required nationally and internationally.
  - Routine collection of accident statistics and usage rates for Micromobility modes (differentiating between Micromobility modes where possible).
  - Increased harmonisation of legislation/rules, ensuring they are well communicated and enforced.
  - Ensure appropriate provision and enforcement of correct parking for PMDs.
  - Consideration of labelling and product environmental footprinting within the PMD industry.
  - Actions to reduce the impacts relating to manufacturing and production of PMDs, including material use.
  - Promotion of maintenance and repair of PMDs in order to expand their lifespan.
  - Actions to increase sustainability of shared scheme operations relating to servicing and redistribution.
  - The setting of clearer goals for PMD use in towns and cities (personal/freight journeys).
  - Reduction of barriers to PMD use where sustainable mode shift can be achieved.
  - Implementation of relevant awareness campaigns, education and training in relation to safety/safe use, legislation and rules, maintenance and benefits.

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INTRODUCTION

- This is the Final Report for **‘Expert study on the safety and environmental impacts of Personal Mobility Devices’** (PMDs).
- The report has been prepared by Ricardo Energy & Environment on behalf of FIA European Bureau.
- The main aim of the study is to gain a deeper understanding of the implications of growing numbers of PMDs on urban roads, from both a regulatory and technical perspective.
- The scope of the project in terms of PMDs includes the following:
  - Electric bikes;
  - Electric scooters;
  - Self-balancing machines; and
  - Cargo bicycles.
- The study examines the following, applicable to the selected PMDs:
  - Existing user/driver requirements;
  - User behavior and awareness; and
  - Safety and environmental aspects.
- The output of the study will be key policy recommendations focusing on improving road safety, minimising impacts on the environment and user convenience, while not adding unreasonable burden and costs on consumers.
- Final outputs will be used to inform FIA’s future position on PMDs in Europe.

METHODOLOGICAL OVERVIEW

Task I: Consolidation and analysis of relevant literature

- Task I.A: Desktop research:
  - Detailed review of existing literature and evidence, primarily from Europe, considering regulatory, safety and environmental aspects of PMD use.
  - Development of an excel-based evidence database.
- Task I.B: Analysis of collected information:
  - Analysis of evidence collected in Task I.A.

Task II: Consumer / stakeholder awareness

- Preparation of three city case studies, exploring the use of PMDs: Paris (FR), Madrid (ES) and Copenhagen (DK).
- Consumer survey with total 2,420 respondents across the three case study cities – to gain an understanding of consumer awareness regarding PMD use and issues.

Task III: Way forward

- Draw upon Tasks I and II to make policy recommendations with a view to improving safety, multimodality and user convenience. Also considering education, awareness and training in relation to PMD use and relating to the topics of regulation, safety and environment.

HOW TO USE THIS REPORT

- Task I.A (desktop research) primarily concerned the undertaking of a detailed review of existing literature and evidence.
- **Evidence database** has been created in excel (accompanying this report), containing over 70 references:
  - Source details
  - Summary of document
  - Type of PMD covered
  - Geographic coverage - Member State / City
  - Period covered
  - Type of data used
  - Legislation / Safety / Environment aspects
  - Market data
  - ‘Other' information
  - Link to source
- Task I.B included the analysis of evidence – which is presented and cross-referenced in this report.

HOW TO USE THIS REPORT

- Task II **Consumer awareness**
  - An annex has been developed which contains the responses to the consumer survey.
  - An overview of key results from the survey are presented in this report.
  - Results based on case study cities are presented in the Annex to this report.
  - Survey responses have complemented the desk research to inform the development of policy recommendations.

- Recommendations
  - Based on the evidence review, **policy recommendations** have been made.

CONTENTS

MICROMOBILITY & PMDS - DEFINITIONS

'Micromobility' and Personal Mobility Devices (PMDs)

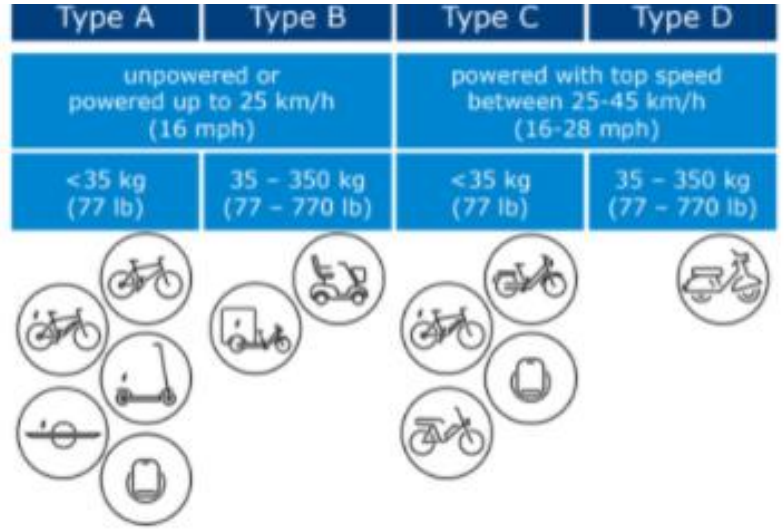
- SAE International (2019)[1]: Entails three criteria:
  - Fully or partially powered
  - Curb weight up to and including 500lbs (227kg)
  - Top speed up to and including 30mph (48km/h)
- ITF (2020)[2]: Micro vehicles with a mass of no more than 771lbs (350 kg) and a design speed no higher than 28mph (45 km/h)

- Difference – SAE excludes human-powered vehicles (i.e., bicycle)
- Recent growth of micromobility is mainly due to electrically powered solutions (see PMDs in Europe)
- Key characteristic of micromobility is the 'shared' aspect – fleets of e-bicycles and e-scooters, either docked or dockless and available to hire for short periods of time more prevalent in Europe

TYPES OF POWERED MICROMOBILITY VEHICLES[1]

	Powered Bicycle	Powered Standing Scooter	Powered Seated Scooter	Powered Self-Balancing Board	Powered Non-Self-Balancing Board	Powered Skates
Center column	Y	Y	Y	Possible	N	N
Seat	Y	N	Y	N	N	N
Operable pedals	Y	N	N	N	N	N
Floorboard / foot pegs	Possible	Y	Y	Y	Y	Y
Self-balancing[2]	N	N	N	Y	N	Possible

[1]All vehicles typically designed for one person, except for those specifically designed to accommodate additional passenger(s)
[2]Self-balancing refers to dynamic stabilization achieved via a combination of sensors and gyroscopes contained in/on the vehicle

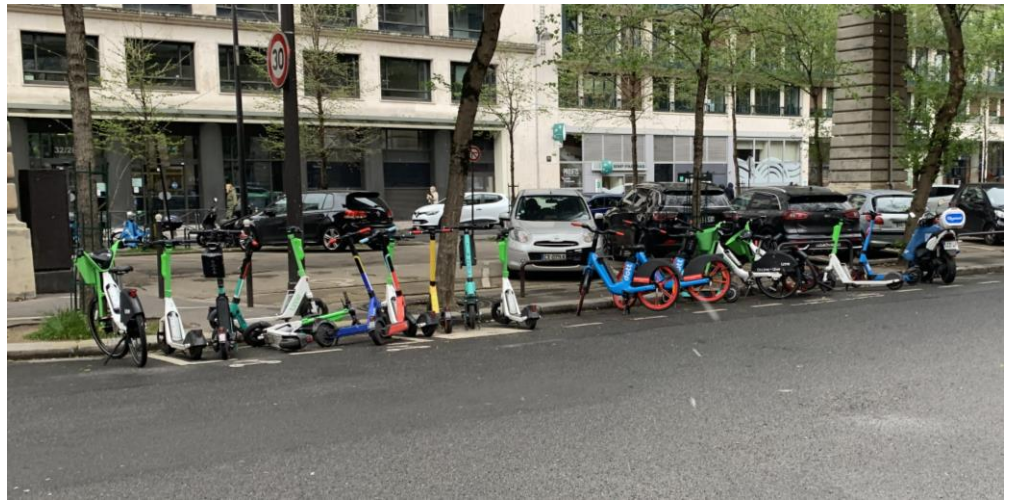


Source: OECD/ITF 2020, Safe Micromobility, https://www.itf-oecd.org/safe-micromobility.

WHY MICROMOBILITY?

Micromobility solutions have the potential to assist in decarbonising urban transport, reducing pollution, congestion and noise, whilst continuing to meet the mobility demands of a growing population and modern economy.

- **Potential benefits**:
  - Convenient and flexible
  - Affordable and cost-effective
  - Complementary to other modes – providing first and last mile multimodal solutions (public transport, walking etc.)
  - Increase accessibility in urban areas (and rural/hilly areas – e-bikes)[2]
  - Contribute to improved air quality and climate change mitigation
  - Potential to increase safety where motorised trips are replace or reduced[1]
  - Health benefits (resulting from modal shift and personal fitness)[2]
- **Potential challenges:**
  - Modal shift – from bikes, walking and PT instead of cars
  - Infrastructure – cities not yet set up for new micromobility options
  - Visual pollution – can detract from cityscapes, particularly if parking is mismanaged



SUPPORTING WIDER EU LEGISLATION & POLICY

Micromobility solutions have the potential to assist in decarbonising urban transport, reducing pollution, congestion and noise, whilst continuing to meet the mobility demands of a growing population and modern economy.

Many European **policy strategies and plans** are in place to transition to cleaner, greener, and smarter mobility, which can include through the use of micromobility solutions:

- The European Commission's zero pollution ambition initially set out in the 2019 European Green Deal
- Sustainable and Smart Mobility Strategy (2020)
- Urban Mobility Framework (2021) which delivers on the SSMS and part of the Green Deal
- Subsequently set out in the EU Action Plan: 'Towards a Zero Pollution for Air, Water and Soil' (2021)

Micromobility solutions can also be a prominent component of the 'Sustainable Urban Mobility Planning' concept for cities and the development of Sustainable Urban Mobility Plan (SUMPs). This is a planning concept applied by local and regional authorities to encourages a shift towards more sustainable transport modes.

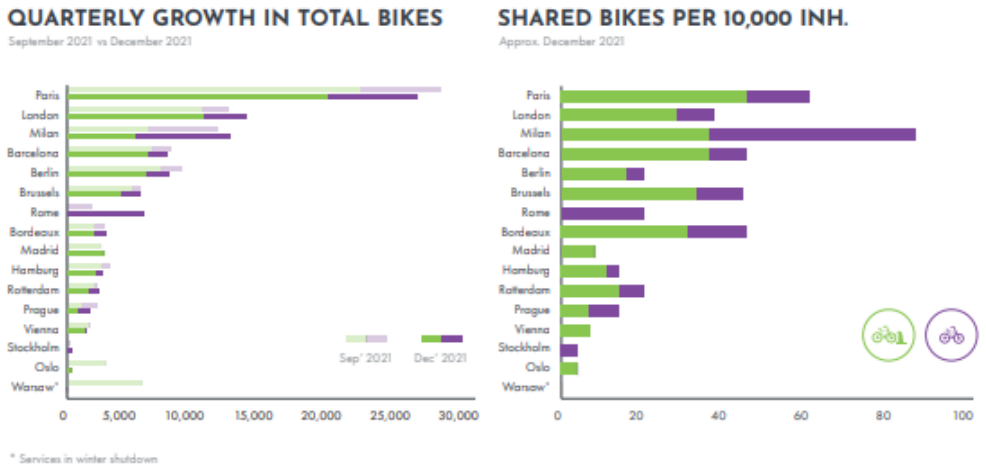
MICROMOBILITY - MARKET ANALYSIS: PMDS IN EUROPE

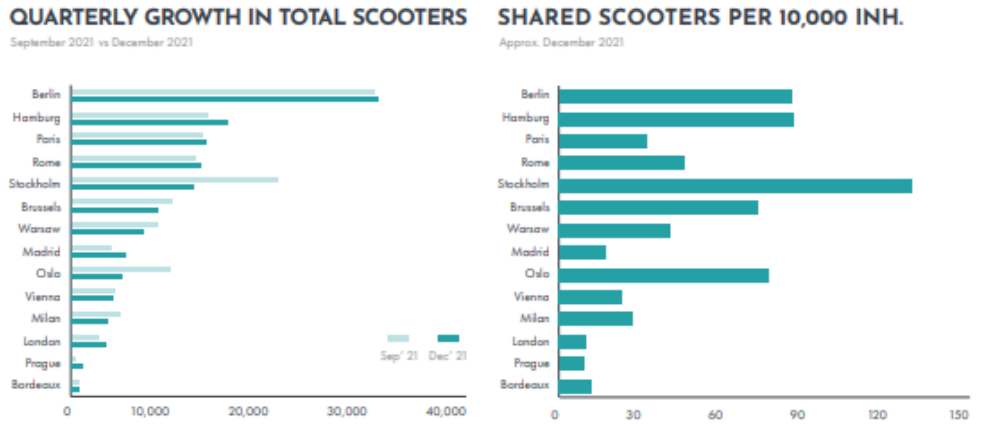
- 20 million bikes and **e-bikes** sold annually in the EU
- Pedal assisted e-bikes increased by 23% from 2018-2019, bringing total number of units to 3.4 million in 2019[1] (representing 17% of bike sales in the EU[1])
- Current estimates of 5 million units in Europe in 2021[2]

- 250,000 **shared bicycles** in Europe, of which 10-20% are electric[2]

European Shared Mobility Index (2021)[3]:

- Covers 16 European cities, 360 services
- Year on year growth (Dec 2000-Dec 2021):
  - Bikes (fixed location) increased 0.5%
  - Bikes (free floating) increased 32%
  - E-scooters increased 124%.





MICROMOBILITY - MARKET ANALYSIS: PMDS IN EUROPE

- Estimated that there are currently 520,000 **e-scooters** available on Europe's streets (June 2022), an increase from 400,000 in February 2022[1].

Shared e-scooter market in Europe (June 2022)[1,2]:

- 600 fleets, across 300 urban areas in 26 countries
- Estimated 360,000 e-scooters available for hire
- Largest operators:
  - 60% of the market – three companies:
    - TIER – 150,000 (75,000 in June 2021)
    - Bolt – 75,000 (42,000, June 2021)
    - Voi - 75,000 (65,000, June 2021)
  - 20% Lime and Bird
  - 10% Dott, Superpedestrian
- Largest fleets are Tier (115 fleets, 2021) and Bolt (100 fleets, 2021)
- Largest single fleet Voi in Berlin (10,000 e-scooters, 2021)

Cargo bikes

- Sales of cargo bikes are increasing significantly.
  - Estimated 400-500,000 will be sold in Europe in 2022.
  - Only one company sold more that 5,000 cargo bikes in 2019 – this has increased to six companies.
  - Average number of cargo bikes in a fleet has more than quadrupled since 2019[3]

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MICROMOBILITY, PMD LEGISLATION

Key legislation (European level):

- Regulation (EU) no. 168/2013: Defines L-category vehicles of two- and three-wheeled vehicles and quadricycles – details how they are approved for sale on EU market and for use in EU Member States.
  - Covers **type-approved PMDs**, including:
    - L1e-A – Powered cycles / e-bikes with speeds up to 25km/h and power cut out at 1000 watts. Also covers cargo bikes.
    - L1e-B – 'Speed' pedelecs / e-bikes with speeds up to 45 km/h.
    - Typically licensed, registered and insured.

- Directive 2006/42/EC: 'Machinery Directive' - Details essential health and safety requirements, approval and certification methods applied to 'machinery' offered for sale in the EU.
  - Covers **non type-approved PMDs**, including:
    - Electrically Power Assisted Cycles (**EPAC**) – Classic e-bike ('pedelec') with speeds up to 25 km/h and power cut off at 250 watts
      - CEN standards for Electrically Power-Assisted Cycles (EPAC)
    - Self-balancing machines
  - No automatic rights for PMDs that are in this category to be placed into service and used on roads
  - Therefore, reliant on national regulations in each Member State to be used on public roads/space etc.
  - Important – no common approach across EU Member States.

MICROMOBILITY & PMD LEGISLATION

Key issues arising from current legislation:

- **Lack of harmonisation of rules at the EU Member State level**:
  - For example, while e-scooters are legally allowed in many EU countries, their legal position differ from country to country – sometimes treated as e-bicycles, light mopeds – depends on power, speed and/or weight (see case study examples).

- **Lack of harmonisation with regards to categorisation of micromobility / PMDs**:
  - Sometimes a separate ‘Micromobility’ category, or included with ‘bicycles’, ‘mopeds’, ‘e-bicycles’ (as an e-scooter) etc. particularly in relation to the collection (or non-collection) of accident data.
  - Correct categorisation of micromobility modes can affect the following:
    - Position on the road
    - Maximum speed/power allowed
    - Helmet legislation
    - Insurance obligation
    - Age restrictions

MICROMOBILITY & PMD LEGISLATION – CASE STUDY CITIES – E-BIKES

E-Bikes	Paris (FR)	Madrid (ES)	Copenhagen (DK)
	Velib (6,500), Lime (5,000), Dott (3,000), Pony (1,500) - 2021 Aiming to be 'car free', and 10% cyclable by 2026 – protected cycle ways and dedicated parking	BiciMAD (3,000) March 2022 – new dockless bikes (including e-bikes) BiciMAD Go, Idbrik Spain, Bird, Boltest, Ride Dott and Lime – operators to ensure bikes are not left on streets	Bycyklen – 130 bike stations situated over the city Donkey Republic, Lime Tier
Where can they be used	Cycle lanes and authorised roads	Cycle lanes Highway Footpath (if neither of above available)	Cycle lanes (should be used where present) Highways (except motorways)
Maximum speed 	25 km/h	25 km/h	25 km/h (motor must not assist above this speed)
Minimum age 	14 years	14 years (on highway)	15 years (recommended)
Helmet 	Optional (mandatory under 12)	Optional	Optional
Other requirements 	Safety lights, reflectors Recyclable batteries Certification meeting French standards	Manufacturer certification required	

Generally consistent in terms of speed, age and helmet use. Some variation in where they can be used.

MICROMOBILITY & PMD LEGISLATION – CASE STUDY CITIES – E-SCOOTERS

E-Scooters	Paris (FR)	Madrid (ES)	Copenhagen (DK)
	Lime, Dott, Tier (5,000 each, 2 year contract) Impose rules at the local level	Lime, Voi, Bird, Move (Babify), Koko, Wheels, Reby, Link, Spin, Wind, Jump	Voi, Bold, Tier and Lime - Reintroduced January 2022 Limited to 4 operators (800 each, 23,200 each) and restricted parking/use 12 month pilot, possible 2 year extension
Where can they be used 	Cycle lanes Roads up to 50 km/h Green lanes and cycle lanes outside of agglomerations.	Cycle lanes Urban tunnels prohibited	Cycle lanes (should be used where present) Highways (except motorways)
Maximum speed 	10 km/h, 20 km/h (designated areas only)	5km/h (cycle paths / peak times) 5km/h at other times. (25 km/h national speed limit)	20 km/h
Minimum age 	12 years	14 years	15 years
Helmet 	Optional	Mandatory (2021)	Mandatory (2022) (€200 fine) Helmets provided by operators
Other requirements	Forbidden to wear ear/headphones Only one person per scooter Lights back and front, reflectors and bell/buzzer No riding under the influence of drink/drugs User insurance is required. Parking only in designated areas (geofencing to enforce)	Forbidden to wear ear/headphones Only one person per scooter Front / rear lights at night Do not use under the influence of alcohol Insurance not required, but recommended.	Front white and rear red lights permanently on Reflectors (front/back, sides). Mandatory CE marking. Max size specifications. Do not use under the influence of alcohol /drugs (0.5 limit) Restrictions on parking

Much more variation in terms of permitted speed, age and helmet use, but also where they can be used.

CONSUMER SURVEY: KEY MESSAGES FOR USE – E-BIKES

Main reasons for use

- E-bikes are a fun way to travel!
- Users/riders also highlight the environmental benefits of e-bike use, and their speed/convenience - helping them to get to their destination quickly

Issues/problems experienced by e-bike users/riders:

  - Interactions with traffic and other vehicles on the road
  - Availability of dedicated cycle lanes
  - Battery charge/charging availability
- **Main benefits/attractions** of e-bike use (of non-/infrequent users):
  - Environmental benefits
  - A cheaper way to travel
  - Speed/convenience – Helping them getting to their destination quicker (compared to walking)
- **Factors that would encourage use an e-bike** (non-/infrequent users):
  - Introduction of cost/financial incentives for purchasing an e-bike
  - Provision of clearly defined road/cycle path space
  - Improved location of pick-up/drop-off/parking
- Just over a quarter of respondents would not be encouraged to use an e-bike

CONSUMER SURVEY: KEY MESSAGES FOR USE – E-SCOOTERS

Main reasons for use

- E-scooters are a fun way to travel!
- Users/riders also highlight the environmental benefits of e-scooter use, and to avoid congestion

Issues/problems experienced by e-scooter users/riders:

  - Poor road/surface maintenance, presenting safety concerns
  - Interactions with traffic and other vehicles on the road
  - Interactions with pedestrians
- **Main benefits/attractions** of e-scooter use (of non-/infrequent users):
  - Environmental benefits
  - A cheaper way to travel
  - The 'fun factor'
- **Factors that would encourage use an e-scooter** (non-/infrequent users):
  - Provision of clearly defined road/cycle path space
  - Clearly defined rules or safety requirements
  - Introduction of cost/financial incentives for buying one
- Over 40% of respondents would not be encouraged to use an e-scooter

CONSUMER SURVEY: KEY MESSAGES FOR LEGISLATION

- Majority of e-bike/e-scooter owners/renters reported that they were **aware of the rules**. They either:
  - Researched before they purchased/rented
  - Were made aware at point of sale/rental
  - Considered rules were well known

- The **rules for use that most e-bike users were familiar with** included:
  - Maximum permissible speed
  - Traffic rules when on the road with other motorised users
  - Obligation to wear a helmet

- The **rules for use that most e-scooter users were familiar with** included:
  - Obligation to wear a helmet
  - Maximum permissible speed
  - Where allowed to use e-scooters

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SAFETY ASPECTS OF PMD USE – ACCIDENT DATA AND REPORTING

Overview

- Micromobility accident and safety data often not consistently collected in EU Member States. Limited available data tends to be for e-bikes (e.g. pedelecs, power-assisted to 25km/h) or on a city-level basis.
- 'Micromobility' categories are mostly absent from statistics, e.g. 'e-bike' accidents are often included in either pedal bike or moped categories, but not consistently.
- Existing studies have utilised hospital, self-reported or insurance data to examine accidents related to PMD use, and tend to focus on e-scooters.
- Studies involving analysis of hospital data also indicate accidents are often underreported to police (i.e. those e-bike accidents that are collected in nationally collected statistics).
- Due to differences in legislation and rules surrounding PMD use in EU Member States/cities, it is not often possible to directly compare accident and safety data where is available.
- Very few operators collate or report on safety statistics – Figures identified for Voi[1], but few others.

SAFETY: NATURE AND CAUSES OF E-SCOOTER ACCIDENTS AND INJURIES

Nature of e-scooter accidents and injuries

- The risk of e-scooter accidents is potentially seven times greater than when using a bicycle[1].
- Studies identified that a large proportion of e-scooter accidents (approx. 80%) tend to be single vehicle crashes[2, 3, 4, 5], i.e. not with another vehicle/pedestrian etc.
- Less than a quarter of e-scooter accidents involve a motor vehicle although when they do, they tend to be more serious[6].
- Those that involve pedestrians (less than 10%) are typically related to the individual tripping over parked e-scooters, rather than collisions[2, 3].
- Injuries sustained whilst riding e-scooters are most commonly associated with the head, face or extremities (rather than chest/abdomen)[2, 4, 5, 7, 8, 9].
- Some studies have reported a higher frequency of accidents occurring at night[2]
- Accidents/ injuries tend to be sustained by males in the 18-25 / 34-38 age categories[5]
- Voi self-reported – Accident rate of 0.005% (all severities; 0.0007% - major/severe) Jan to Apr 2021[10]

Causes of e-scooter accidents (& near misses)

- Use of alcohol/drugs[1] - e.g. alcohol played a part in 30% of accidents in Cologne[3,4,5,7,9]
- Disregard of traffic rules[3,5,11,12,13]. Can include misuse of one-way streets, truck routes, use of pedestrian paths etc.
- Excessive speed[3,4,7,11,12]
- Carelessness / distraction[3,13]
- Inexperienced users[4,7,8,11]
- Conflicts over space, e.g. e-scooter riders and cyclists/pedestrians, other road users[7]. "*Too slow for traffic, too fast for pedestrians*"[13]
- Road surface/maintenance[2,3]
- Parking of e-scooters (causing injury to others)[3,11,12]. Particularly for pedestrians, elderly, blind, disabled[13].

SAFETY: NATURE AND CAUSES OF E-BIKE ACCIDENTS AND INJURIES

Nature of e-bike accidents and injuries:

- Fewer studies relating to e-bike safety and accidents[1]
- Riders of e-bikes tend to be older than pedal cyclists
- Lower fitness and increased vulnerability of elderly e-cyclists may contribute to higher risk and impact of injuries likely to be more severe.[4,5] However, the more prudent riding styles of elderly riders may counteract these risks[5]
- When comparing e-bikes with pedal bikes, no higher risk identified in relation to accidents. However, e-bikes enable the relatively vulnerable elderly to cycle longer and more often, which could lead to an increase in the number of serious road injuries (exposure effect)[2]

Are e-bikes inherently more unsafe than pedal cycles?

- E-bikes up to 25km/h do not appear to be more dangerous than regular bicycle when trip distances and age are controlled for[3]
- Research suggests that the risk for an e-bike is seven times higher for a fatal crash and two times higher for severe and light injuries compared to pedal cycle (e-bike usage data / crash statistics)[5]

Causes of e-bike accidents (& near misses)

- Where information is available, tends to suggest that e-bike accidents relate to mounting/dismounting (battery weight/weight distribution), but also due to age (older riders)[2]
- Literature suggests that e-bikes and cycles with e-assist are often ridden faster which could lead to increased safety risk
- Survey revealed that 29% of respondents stated that accidents involving e-bikes might not have taken place if conventional cycles were used
- From the literature, some of the main reasons for e-bike accidents included:
  - Underestimation of speed of electric bikes by other road users
  - Errors and aggressive behaviours
  - Illegal occupation of motor vehicle lanes and red-light running
  - Crashes most likely to occur on curves and while overtaking
  - Individuals/riders with a driver's licence are less likely to cause accidents

SAFETY: NATURE AND CAUSES OF OTHER PMD ACCIDENTS AND INJURIES

Cargo bikes:

- Very little evidence available relating to safety of cargo bikes / cargo e-bikes
- E-bike accidents/safety have been used as a proxy in the discussion relating to e-cargo bike safety in the literature
- Acknowledged that statistics for accidents involving bicycles are sometimes further defined as an e-bike category, but rarely determine whether this is a cargo bike. Therefore safety implications are underreported and largely unknown[1]
- Cargo bikes tend to be heavier, longer and wider than conventional bikes, with a larger turning circle. Safety concerns relate to lack of adequate road space and limited ability to tilt when turning corners[1]
- Crash testing of e-cargo bikes (25km/h colliding with a stationary vehicle) revealed that children being carried in the cargo box are at risk of (primarily) head injury[2]
- A survey revealed that 8 out of 10 respondents were not comfortable sharing roads with cars, requiring dedicated cycle lanes. However, cycle lanes are often narrow, and would have to be widened to ensure riders of cargo bikes feel safe[3]

Self-balancing machines:

- Although limited information was available specifically on safety and accidents related to use of self-balancing machines, one study recognised that the injuries sustained in accidents were similar to those sustained when riding e-scooters, i.e. head, and extremities (rather than chest/abdomen)[4]

SAFETY: CASE STUDY CITY ACCIDENT DATA AND REPORTING

Paris (FR):

- National road traffic accidents do not appear to include bicycles, or any micromobility options

Madrid (ES):

- Madrid database of accidents reported to the police (City of Madrid) – includes 'e-bikes' (EPAC) and 'VMU electricos' (electric vehicles of urban mobility – which includes e-scooters)
- Road accidents involving bicycles (since 2019) registered by municipal police (City of Madrid). No differentiation between bike / e-bike
- National traffic accident statistics – no differentiation between bicycles/e-bikes

Copenhagen (DK):

- National traffic accidents (injured/killed) - includes 'bicycle' and 'others'
- Individual studies on e-scooter accidents in Capital region of Denmark

SAFETY: CASE STUDY – ISSUES AND CONCERNS

Paris (FR):

- PMDs exist in huge numbers, particularly e-scooters, causing safety concerns for pedestrians in particular
- Changing legislation
- There is a clear lack of understanding from users of the safety requirements and rules (both buying and renting), including from available/advertised information, and own research

Madrid (ES):

- Complex regulation for e-scooters in terms of speed, day, location etc.
- Many e-scooter providers – this could leave to confusion and differing levels of information being provided to users
- Lack of known/advertised understanding for both purchasing and renting e-bikes/e-scooters

Copenhagen (DK):

- Large number of e-scooters and operators previously in the city
- Poor parking across city for e-scooters (and lack of official parking in ‘dense city’), leading to safety concerns
- Lack of restriction of e-bikes on roads alongside other motorised vehicles
- There is a clear lack of understanding from users of the safety requirements and rules (in particular for renting)

SAFETY: POLICY CONSIDERATIONS & RECOMMENDATIONS (LITERATURE)

Establish mechanisms to further understand PMD safety:

- Need to develop consistent categories for ‘micromobility’ & PMDs
- Will enable appropriate collection, analysis and reporting of accident and injury data for PMDs
- Regular statistics and data increasing the understanding of micromobility / PMD-related safety concerns
- Will help to shape future policy recommendations addressing safety

Development of legislation and rules to increase safety

- Where possible, harmonisation of rules – EU, national, local
- Potential for EU Member States to work on more elaborate and targeted legislation - Untargeted legislation can negatively impact on the level of enforcement[1].
- More clearly defined categorisation will also benefit accident reporting, and therefore safety more generally[2,3]
- Increase awareness and reduce confusion / ambiguity

Address the key causes of accidents and safety concerns– PMDs:

- Adequate parking for PMDs[4,5]
- Make rules clearer for users[4]
- Limit speeds – 25km/h (shared with cyclists / motor vehicles)[4,6]
- Separate vehicle types[4]
- Rules regarding alcohol/drugs[4]
- Pricing mechanisms – price per km rather than min – could influence safety[4]
- Better data management – increased accountability[4]
- Collect data about accidents and risks – to in turn increase safety[6]
- Road maintenance to reflect needs of PMDs[5]

SAFETY: POLICY RECOMMENDATIONS (LITERATURE)

E-Scooters:

- Helmets / protective equipment[1,2,3]
- Training[1,3,4] - particularly for new /infrequent users
- US study – Accident risk decreases with experience[5,6]
- Keeping number of available scooters to a safe maximum (public)[1]
- Speed limits[1]

E-Bikes:

- Helmets

Self-balancing machines:

- Use of helmets and wrist guards (preventing head injuries)

Cargo bikes:

- Consider wider cycle lanes (separation from road traffic)[7]

Mandatory use of helmets:

- Helmet use is often recommended when using an e-scooter. However, a number of EU Member States have recently made helmet use mandatory, including Spain (2021) and Denmark (2022).
- Decision reflects the nature of accidents (head injuries), and increasing concerns over safety.
- Mandatory helmet use for bicycles / e-bikes still varies across the EU, but with a tendency for helmet use to be optional.
- However, concerns remain relating to whether mandatory helmet use can deter uptake of Micromobility use[3]

CONSUMER SURVEY: KEY MESSAGES FOR SAFETY – E-BIKES

Feelings/perceptions of safety:

- E-bikes are considered to be safe for e-bike users/riders, and to lesser extent, for other road users and pedestrians
- However, a third of pedestrians do not feel safe when interacting with e-bikes and nearly 30% of e-bike users do not feel safe interacting with motorised road vehicles

Accidents:

- Most e-bike user/rider accidents involved the following:
  - Car (nearly 30%)
  - Other cyclists (14%)
  - Taxi (13%)

Measures to increase safety for e-bike users/riders:

- Provision of dedicated cycle lanes for e-bikes
- Requirements for mandatory helmet use
- Better enforcement of road/use rules
- Improved road/surface maintenance
- Lower speed limits for other motorised road users

CONSUMER SURVEY: KEY MESSAGES FOR SAFETY – E-SCOOTERS

Feelings/perceptions of safety:

- E-scooters are not considered safe for e-scooter users, and less so for other road users and pedestrians
- Nearly 60% of pedestrians do not feel safe when interacting with e-scooters
- One third of e-scooter users/riders do not feel safe interacting with motorised road vehicles

Accidents:

- Most e-scooter user/rider accidents involved the following:
  - Car (22%)
  - Cyclists (16%)
  - Pedestrians (13%)

Measures to increase safety for e-scooter users/riders:

- Provision of dedicated cycle lanes for e-scooters
- Requirements for mandatory helmet use
- Better enforcement of road/use rules; Improved road/surface maintenance
- Lower speed limits for other motorised road users

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ENVIRONMENTAL ASPECTS OF PMDS – MODAL SHIFT

- Modal shift towards the use of small, lightweight PMDs can potentially support sustainable transport policy, leading to a range of environmental benefits:
- **Reduced car dependency:** Includes addressing problems associated with **traffic and congestion**, **noise**, delays/commuting **time** and **stress**[1,5,6,12]
- **Contribute towards improvements in air quality:** Modal shift from motorised vehicles can lead to improvements in air quality (that may have a much broader human health effect), or reductions in the contribution of transport to **carbon emissions and climate change** [9]
  - E-scooters and e-bikes use significantly less energy and emit much less GHG per person-kilometre over their lifecycle than cars[3]
- **Increased accessibility/mobility in urban areas:** PMDs can facilitate many different short trips. The added electric power can help users travel longer distances, ride at higher speeds and cope with natural borders (wind etc.), and encourage other users that may not be physically able to use bikes/scooters ordinarily[7]
  - Their use can contribute to more efficient use of parking and other shared public spaces[2]
  - PMDs can act as a **last mile solution** (personal, and for delivery drivers such as Uber Eats) and can make some public transport /other trips viable that perhaps would have been made by car
  - Use can **increase the catchment area of public transport** - combining buses/metro/urban trains with different PMDs results in a similar level of GHG emissions per km as single use of buses/metro/urban trains. Therefore, whilst PMDs have limited capacity to completely replace/remove car travel, they also have a strong capacity to be relevant as a segment of longer intermodal trips, which could strengthen their capacity to compete with car travel[2,3]
  - **Physical activity benefits** could be reduced if e-bikes are substituted for conventional bike use. However, there is evidence available that suggests that e-cyclists compensate the ease of electric assist by riding further and more often[13]
- However, increased use of PMDs can also **increase visual pollution through improper parking**[4] This can be especially problematic for people with impaired vision, difficulty walking or using wheelchairs[10] (see also safety aspects)

ENVIRONMENTAL ASPECTS OF PMDS – MODAL SHIFT

- Shift to PMDs can also benefit the **private delivery sector**, resulting in a number of benefits.
- **(E-)cargo bikes** (in particular) have been identified as a potential solution to rising numbers of vans/delivery vehicles in urban areas
- A study[1] identified evidence from a range of sources that suggests (e-)cargo bikes could replace vans and other vehicles and play a role in city logistics, including the following:
  - Courier services
  - Post services
  - Gig-economy (e.g. food delivery services)
  - Service vehicle (e.g. plumbers, electricians etc.)
  - Delivery services (e.g. SMEs)
  - Urban consolidation centres – last mile deliveries
- "***Cycle logistics most suited to dense urban areas, with relatively high concentrations of suitable delivery work, or where individual trips are relatively short***"
- Estimated that commercial bikes across Europe could generate €2.5bn in revenue, employ 170,000 people, and save 302,000 tonnes CO_2 per year (projected)[5]
- Estimated that **10-30% of trips made by deliver/service companies could have the potential to be replaced by (e-)cargo bikes**. Whereas another study estimated up to 51% of all motorised trips associated with the transport of goods could be shifted to (e-)bike (1/3 attributed to commercial transport and 2/3 private logistics – e.g. shopping and/or leisure)[3]
- (E-)cargo bikes have the **potential to replace 1.5-7.5% of all urban vehicle mileage** (based on delivery/service companies making up 15-25% of all urban vehicle mileage)[3]. Another study suggested that 25% of all goods and 50% of all light goods could be moved by cycle in urban areas[4]
- Significant **reductions in carbon emissions** and **improvements in city air quality** could be achieved. Estimated that commercial delivery is responsible for 30% of transport CO_2 emissions, over 50% of NOx emissions and 40% of particulate matter. Noise (particularly associated with large delivery vehicles) is also an issue.
- Possibility to take **shorter, more direct routes**
- **Quicker journey times** in built up areas where (e-)cargo bikes are able to avoid congestion
- **Increased number of delivery stops**, due to ease of parking (and short/faster routes) – estimated that they can deliver 60% faster than vans in cities[5]
- **Health benefits** also realised for the riders

ENVIRONMENTAL ASPECTS OF PMDS - MODAL SHIFT

- Due to the recent increase in PMD use (shared and private), it is still unclear whether there is an overall positive impact on the realisation of environmentally-related targets, particularly in terms of mode shift from other motorised modes of transport.
- There is a risk that instead of replacing private car trips, **PMD use can replace other 'sustainable transport modes'**, such as walking, cycling or public transport (bus, metro etc.)[1] or create new trips.
- Research found that for personally owned e-bikes, the **range for which car journeys were substituted was between 20% to 86%[2,3]**. Typically, personally owned e-bikes tend to replace trips made by car, foot, pedal bike and public transport, whereas **shared e-bikes tend to replace substantially fewer car trips and more public transport and pedal bike trips**[3].
- Another study suggested that the **impact of e-bike use on travel behaviour depends on the primary mode prior to e-bike use**. In Antwerp, e-bike users previously primarily used a conventional bike (34%) or private car (38%), whereas in Zurich, e-bike trips primarily substituted public transport trips (22%)[4]
- **E-scooters (which tend to be used for very short trips) have been found to replace substantially more walking trips than e-bikes**[3] . They also tend to replace trips that would have otherwise been made by public transport and cycling, and not by car[5].
  - ADAC (2022) study suggested that the replacement of public transport trips by PMDs is not necessarily negative, particularly if they replace a difficult journey with a number of connections, which could have positive implications for the user[6].
  - The study also found that e-scooter journeys over 2km tended to be more sustainable, as they are likely to be replacing private car trips. Trips under 2km could feasibly be undertaken on foot[6].
- A study by TIER showed use of their e-scooters have replaced car rides on average by 17.3%[7,1]
- **E-scooter sharing schemes have been shown to have a lower environmental impact than private car use** – although they are still not as environmentally friendly as walking, cycling or using public transport[5].
  - For example, one study found that use of e-scooters instead of motor vehicles in Paris prevented more than 330 metric tons of CO_2 emissions in 2018
  - However, another LCA study also highlighted estimates that some additional tons of CO_2eq have been generated in Paris due to the shift from already low-emitting modes (60% of users from a survey previously used the metro and RER[8] and 22% previously used other active modes)[9]

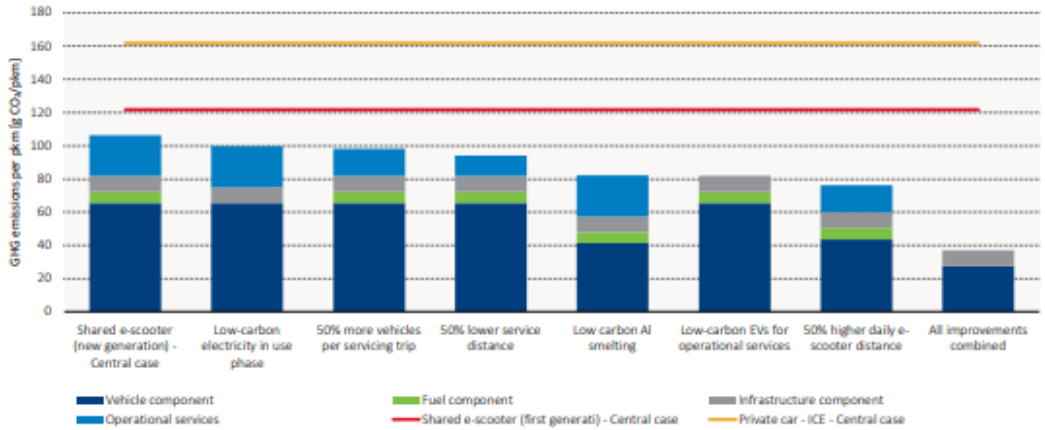
ENVIRONMENTAL ASPECTS OF PMDS – LIFECYCLE & SERVICING

- Lifecycle impacts of PMDs relate to use of raw materials and manufacturing, use (including fuel cycle) and end of life recycling.
- A significant proportion of the lifecycle impact of PMDs can be attributed to the **materials and manufacturing process**[1]. For example, the use of raw material for e-scooters is estimated to contribute to between 68% and 90% of total carbon footprint[1]. Materials and manufacturing combined with daily operations of PMDs drive an estimated 93% of the climate impact [2].
  - **Battery production** is also one of the most carbon-intensive parts – they often also make up to 50% of the overall costs of an e-bike (between €300-1,000)[3].
  - Materials such as **aluminium** constitute half of an e-scooter weight and drives up energy consumption necessary to separate the metal from the oxide.
- Negative impacts can be expected during **end-of-life** from the disposal of the PMDs and their batteries into landfill[4,5]. Batteries are often tailored to manufacturers and specific models – creating barriers to replacement and repairs and leading to shorter product lifetimes, increased electronic waste and unnecessary monetary expenditure[3].
- Bike manufacturer Trek undertook analysis to understand the emissions associated with the production of their bikes and components for a range of their popular models, including an electric bike:
  - Emissions ranged from 116kg CO_2e (entry level mountain/hybrid bike) to 229kg CO_2e (electric bike). Additional emissions relating to the electric bike are primarily associated with the battery, battery charger and motor assembly.
  - TREK's analysis showed that if the users ride 430 miles by bike rather than a motorised mode of transport, then the carbon cost of bicycle purchase is offset (based on average emissions across a range of products)[6].
- Several studies have been undertaken exploring the **lifecycle impacts of PMDs compared to other modes**:
  - Analysis suggests the carbon footprint of selected e-scooters has reduced since their initial implementation (a 70% reduction in CO_2per km, down to 35g CO_2per km since January 2019)[2].
  - Research suggests that lifecycle GHG emissions from an e-scooter, on a per km basis, may be around 37% lower than those of conventional private cars and 60% lower of shared bikes[4].
  - Lifecycle analysis shows that e-bikes are both more energy efficient and less polluting than conventionally-powered motor vehicles and public transport systems[7].

ENVIRONMENTAL ASPECTS OF PMDS – LIFECYCLE & SERVICING

- ITF/OECD (2020)[1] consider the lifecycle GHG emissions of first-generation and new generation of shared e-scooters and the effects that further improvements for their further reduction.
- Sensitivity analysis performed to consider changes in average daily distance, average vehicle life, number of vehicle servicing trips, average distance travelled by servicing trip, carbon intensity of electricity used by vehicles, and other aspects

Figure 8. Life-cycle greenhouse emissions of the new generation of shared e-scooters and effects of further improvements for their further reduction



Note: Al = aluminium; EV = electric vehicle.

- LC GHG emissions are already lower than the shared e-scooter (first generation) central case, at just over 100g CO_2/pkm

- Changes in average daily distances – More kms leads to lower impact of GHG and energy per km.
- Changes in e-scooter lifetimes – lower lifetimes also mean lower lifetime mileage, and therefore higher GHG / energy impacts
- Changes in operational practices – maximising number of e-scooters serviced in a single trip, and reduction in trip distances leading to improvements in GHG emissions and energy
- Use of carbon intensity reduction technologies (e.g. in material production.
- Use of low energy /GHG emission service vehicles, either EVs or dedicated cargo bikes.
- Consideration of increased weight - can lead to net increases in energy and GHG emissions/pkm, but can also realise reductions is lifetime of e-scooter is extended.

ENVIRONMENTAL ASPECTS OF PMDS – LIFECYCLE & SERVICING

- In addition to the emissions associated with electricity production for the use phase, PMD **collection and distribution of shared e-scooters and e-bikes and charging strategies** can all have a potentially negative environmental impact and increase GHG emissions[1,2]
- A number of factors can affect emissions associated with the operation and maintenance of shared e-scooter and e-bikes:
  - Vehicles used to collect, distribute and perform servicing of PMDs – Vehicles with internal combustion engines, versus electric vehicles or more innovative solutions such as cargo bikes
  - Planning associated with the collection, distribution and servicing, including consideration of the **distances travelled** and areas covered in a particular trip
  - Charging strategies for e-scooters and e-bikes, and consideration of use of **swappable batteries**
    - Swappable batteries could cut operational emissions drastically by reducing the daily transport charge by 90% as only batteries are transported to be charged and deployed[3,4]
    - Swappable batteries allow for cargo bikes and trailer bikes to perform 75% of their in-field tasks. Vehicles will have less weight to carry, which will reduce the number of vehicle kilometres travelled, and this can support the adoption of centralised charging stations to further reduce vehicle kilometres travelled[3,4]
    - Swappable batteries also enable more rides to be provided with the same fleet size, as scooters have much shorter downtime[3]

ENVIRONMENTAL ASPECTS OF PMDS – LIFECYCLE & SERVICING

- The average lifespan (use phase) of PMDs significantly affects the total lifecycle emissions and impacts of PMDs
- Research from the USA suggested that the average lifespan of shared e-scooters was approximately 28 days (2019)[1]
- More recent research (2021) revealed that the typical lifespan of a shared e-scooter is 2-5 months (average 3 months), after which it is scrapped. This is in comparison to privately owned e-scooters, which can last up to 3 years [2,3]
- The low lifespan of shared e-scooters is due to e-scooters being damaged, stolen, vandalised and being replaced for newer models
- Other considerations that affect the lifespan of e-scooters include:
  - **Where they are stored** – shared e-scooters are typically outdoors and exposed to all weathers
  - **Riding habits** – determined by the users. Inexperienced or non-owners are likely to have poorer riding habits that will negatively affect the lifespan of the e-scooter (full throttle, sudden braking etc.)
  - **Tyres and general maintenance** – regular maintenance required. Replace parts or swap batteries to extend PMD life
- Due to the significant contribution that the materials and manufacturing of PMDs has on their total lifecycle emissions, extending the lifespan of PMDs during the use phase will therefore have a significant effects on reducing the overall impact of PMDs
- The expansion of lifespan can lead to a reduction in Global Warming Potential (GWP) associated with their use[5,6]

ENVIRONMENT: POLICY RECOMMENDATIONS (LITERATURE)

Ensure modal shift for sustainability and foster public transport – micromobility collaboration:

- Set clearer goals towards the greater use of PMDs[2]
- Integrate micromobility use with public transport – promote public transport and walking, cycling etc simultaneously[2,4,14]
- Introduce financial incentives offered to manufacturers – to make devices more commonly available[13]
- Widening the definition of alternative sustainable mobility to include micromobility options

Invest in ways to extend the lifetime/lifecycle of the PMDs:

- Focus on repair and reuse programs, getting vehicles back into operation whenever possible, rather than replacing for new vehicles [2,12]
- More universal battery packs and management systems for models are needed so they can be repaired/replaced more easily[1,6]
- Invest in durable design improvements and guiding user behaviour that discourages tampering or vandalism [2,9]
- Dedicated parking should be available which would help vandalism issues[9]

Decrease emissions and environmental impact associated with PMDs:

Servicing and maintenance:

- Use energy efficient vehicles in distribution activities (EVs or cargo bikes) [2,3,4,5,7,8,9,10]
- Reduce vehicle miles travelled for collection/distribution through centralised management and route optimisation (operational efficiency) [2,3,7,8,9]
- Removable/swappable batteries so vehicles can remain in location [3,4,5,6,7,9,10]
- 100% renewable/green energy to charge PMD batteries [4,9,14]

Production and end-of-life:

- Adopt technologies that reduce the carbon intensity of material production (e.g. nickel instead of cobalt in battery production[11]) including greater use of recycled content e.g. aluminium [2,4,5,8]
- Explore more advanced recycling methods for the batteries [5]
- When a vehicle cannot be repaired, break it down for parts to be reused or recycled [3]

CONSUMER SURVEY: KEY MESSAGES FOR ENVIRONMENT

E-bikes and e-scooters:

- Most respondents (51%) always/often take environmental considerations into account when choosing their mode of transport.
- However, 78.6% of frequent users of e-bikes and e-scooters always/often take environmental considerations into account when choosing their mode of transport.
- Respondents recognise that journeys by e-bikes and e-scooters in towns and cities can be beneficial in terms of a substitute for personal car trips, including reducing congestion and realising environmental benefits (improved air quality).
- E-scooters to a lesser extent, perhaps due to the lower trip distances typically covered compared to e-bikes.
- However, respondents also recognise that e-bikes and e-scooters are sometimes regarded as a better substitute for walking trips and public transport trips.

CONSUMER SURVEY: KEY MESSAGES FOR ENVIRONMENT

E-bikes:

- A quarter of respondents agreed that e-bikes have a **negative impact on cityscape and public space** in their city.
- There is a high level of agreement that e-bikes are **better for journeys in built up areas** (57.1%), that e-bike trips make **short trips more convenient** (64.5%) and that they will **help to improve air quality** in towns and cities (69%). 63.8% respondents agree that e-bikes are a better substitute for car trips in towns and cities, and that they will reduce congestion (55.2%).
- However, 49.9% respondents agree that e-bikes are a better substitute for PT in towns and cities, and 37.9% for walking.

E-scooters:

- 43% of respondents agreed that e-scooters have **a negative impact on cityscape and public space** in their city.
- There is a **high level of agreement** that e-scooters are **better for journeys in built up areas** (47.6%), that e-scooter trips make **short trips more convenient** (52.6%) and that they will **help to improve air quality** in towns and cities (56.4%). 45.2% respondents agree that e-scooters are a better substitute for car trips in towns and cities, and that they will reduce congestion (42.4%).
- 36% respondents agree that e-scooters are a better substitute for PT in towns and cities and 31.9% for walking.

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CONSUMER SURVEY: RESPONDENTS

2,420 responses to the survey across three cities

Key respondent characteristics		ALL	Copenhagen	Paris	Madrid
Gender	**Male**	1,136	387	357	392
	Female	1,276	418	448	410
	Another / prefer not to answer	8	2	3	3
Age	**18-20**	103	32	42	29
	21-24	143	48	47	48
	25-34	384	118	139	127
	35-44	456	135	162	159
	45-54	455	151	148	156
	55-64	398	134	130	134
	65+	481	189	140	152
Licences held	**Car**	2026	633	687	706
	Motorcycle	390	86	114	190
PMD use	**High frequency (several/week)**	294	100	97	97
	Medium frequency (several/month)	375	94	114	167
	Low frequency (at last once in year)	554	225	160	169

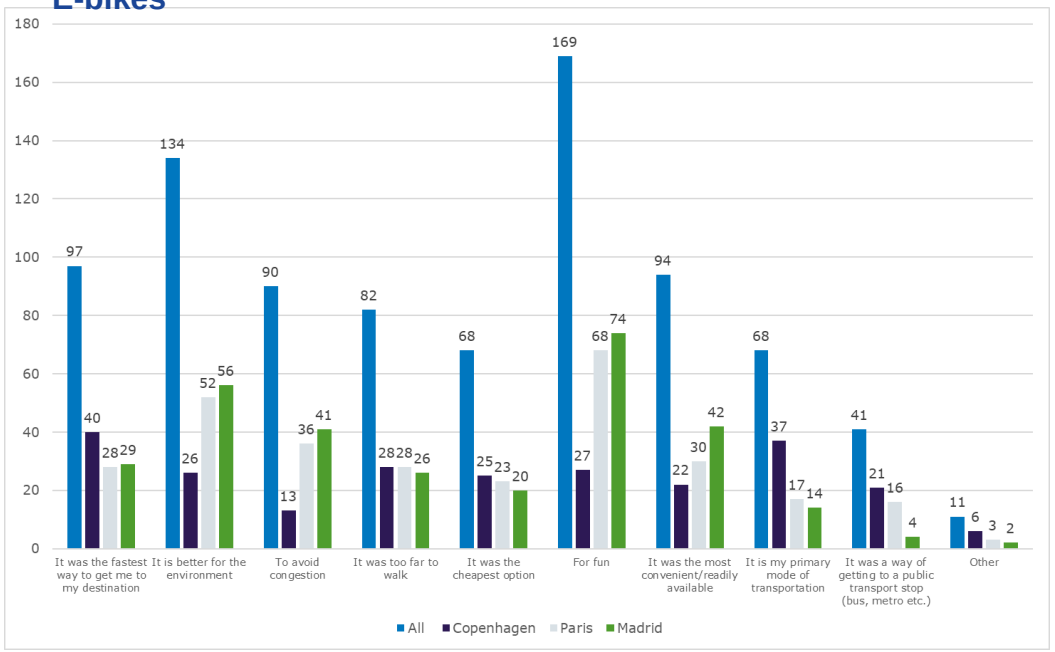
Where similar questions were asked in the ADAC (2022) survey (e-scooters), responses have been added to the summary presented.

CONSUMER SURVEY: PMD USE

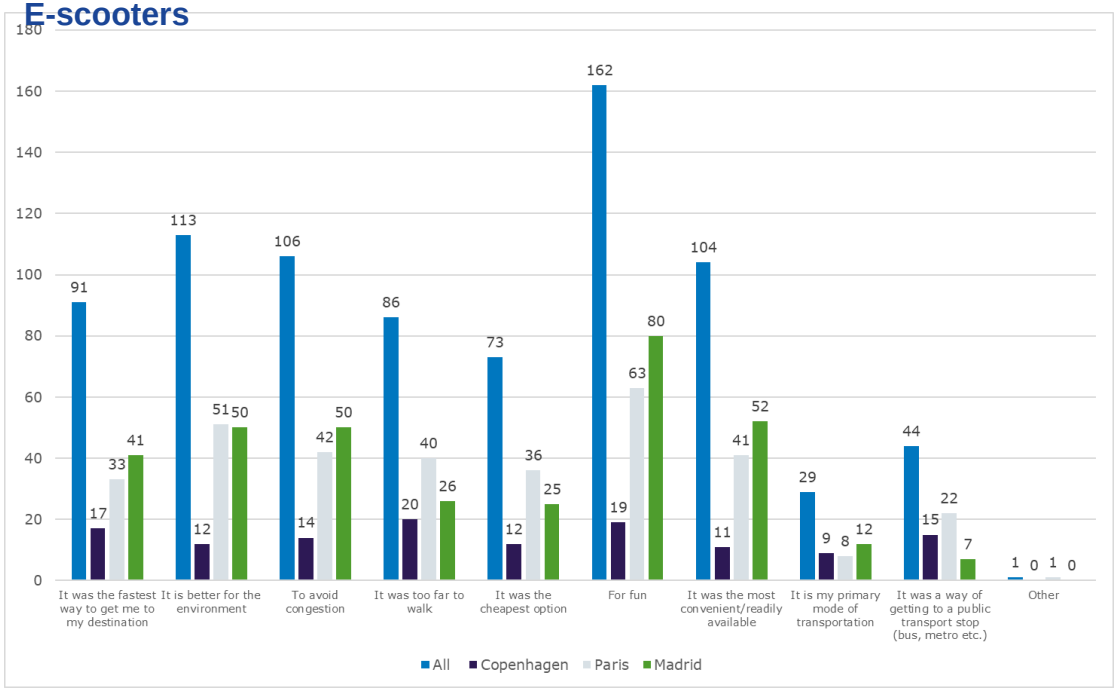
'*What were your reasons for choosing e-scooter/e-bike?*' [Respondent has used in the last 6 months]

- '**For fun**' and '**It is better for the environment**' top responses for both e-bikes and e-scooters
- Other top responses:
  - **E-bikes:** 'it was the fastest way to get to my destination', 'it was the most convenient/readily available' and 'to avoid congestion'
  - **E-scooters:** 'to avoid congestion', 'it was the most convenient/readily available' and 'it was the fastest way to get to my destination'
- ***ADAC (2022) survey:*** *E-scooters are fun, alternative to walking, available at all times, quicker to navigate city and alternative to public transport*

E-bikes

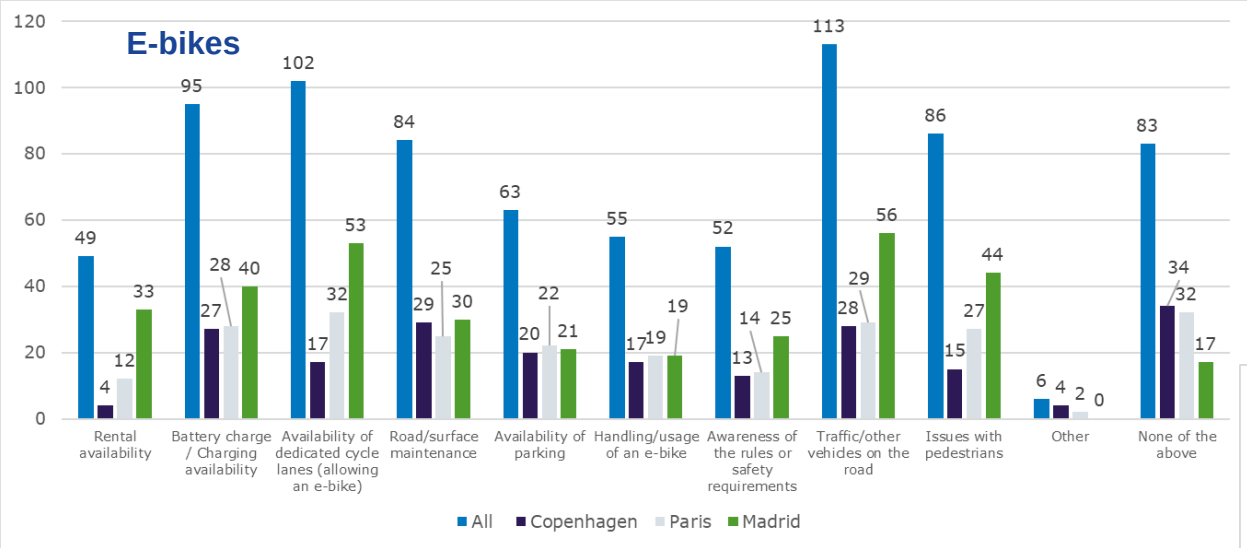


E-scooters



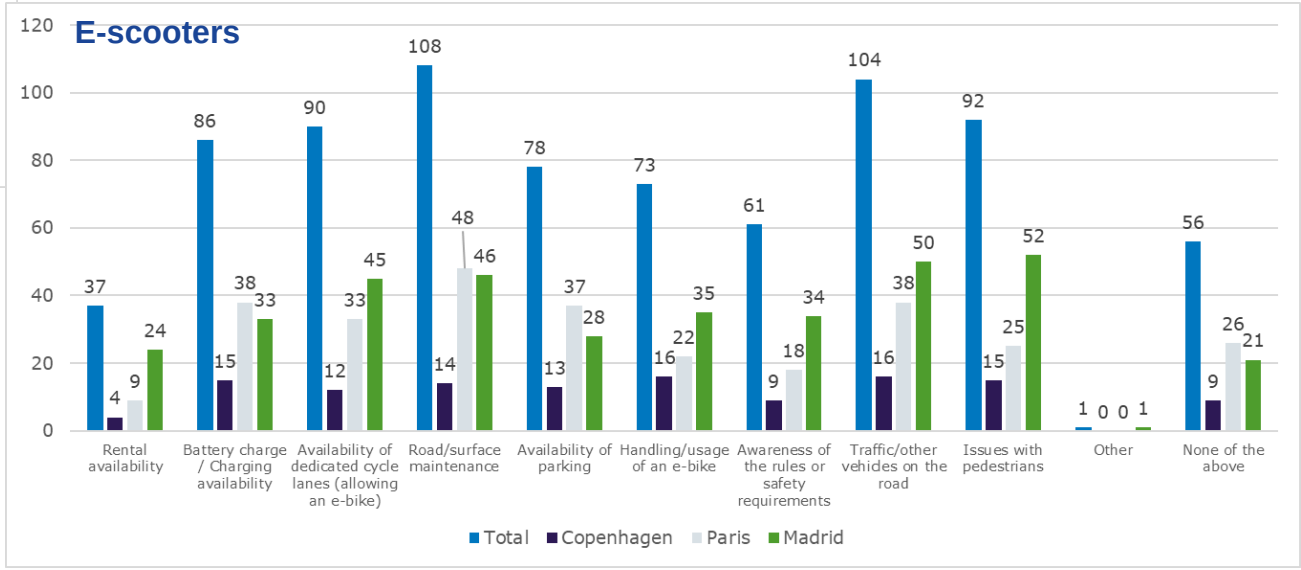
CONSUMER SURVEY: PMD USE

'Have you experienced any issues/problems when using an e-scooter/e-bike in the past?' [Respondent has used in the last 6 months]



- **E-bikes:**
  - 'Traffic/other vehicles on the road' (28.5%)
  - 'Availability of dedicated cycle lanes' (25.8%)
  - 'Battery charge/charging availability (24%)
  - 'Issues with pedestrians' (21.7%)
  - 21% indicated that they did experience any of the issues listed

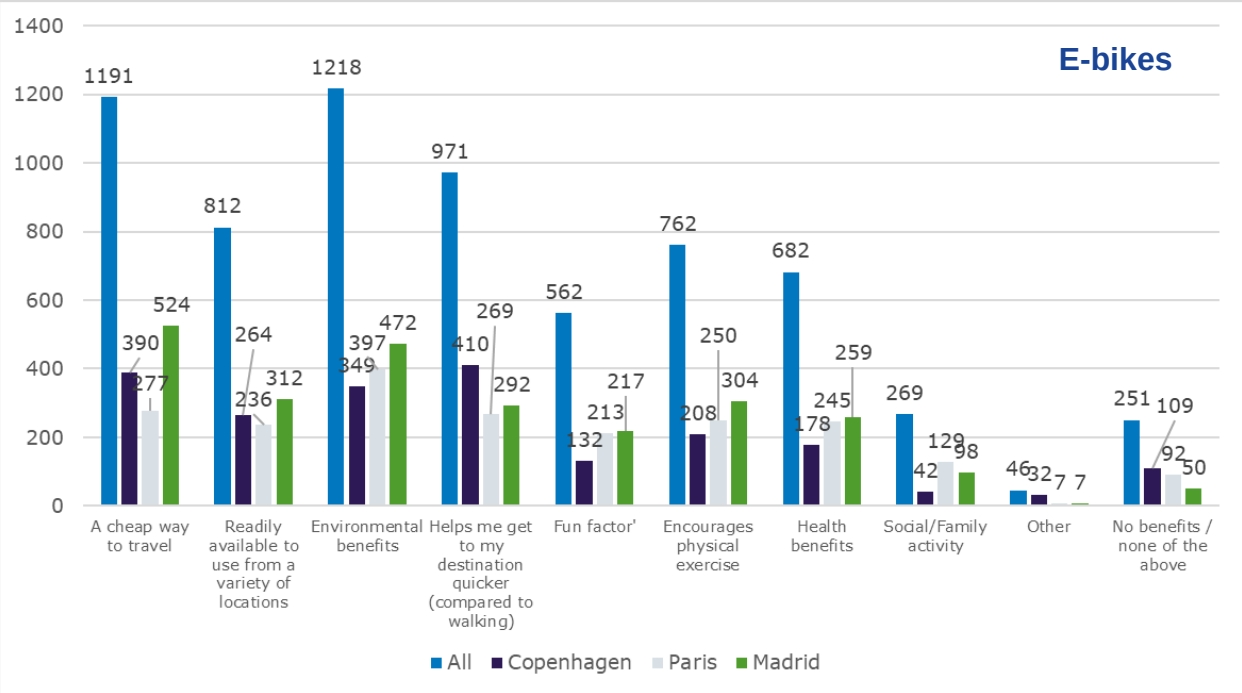
- **E-scooters:**
  - 'Road/surface maintenance' (28.8%)
  - 'Traffic/other vehicles on the road' (27.7%)
  - 'Issues with pedestrians (24.5%)
  - 'Availability of dedicated cycle lanes' (24%)
  - 14.9% indicated that they did experience any of the issues listed

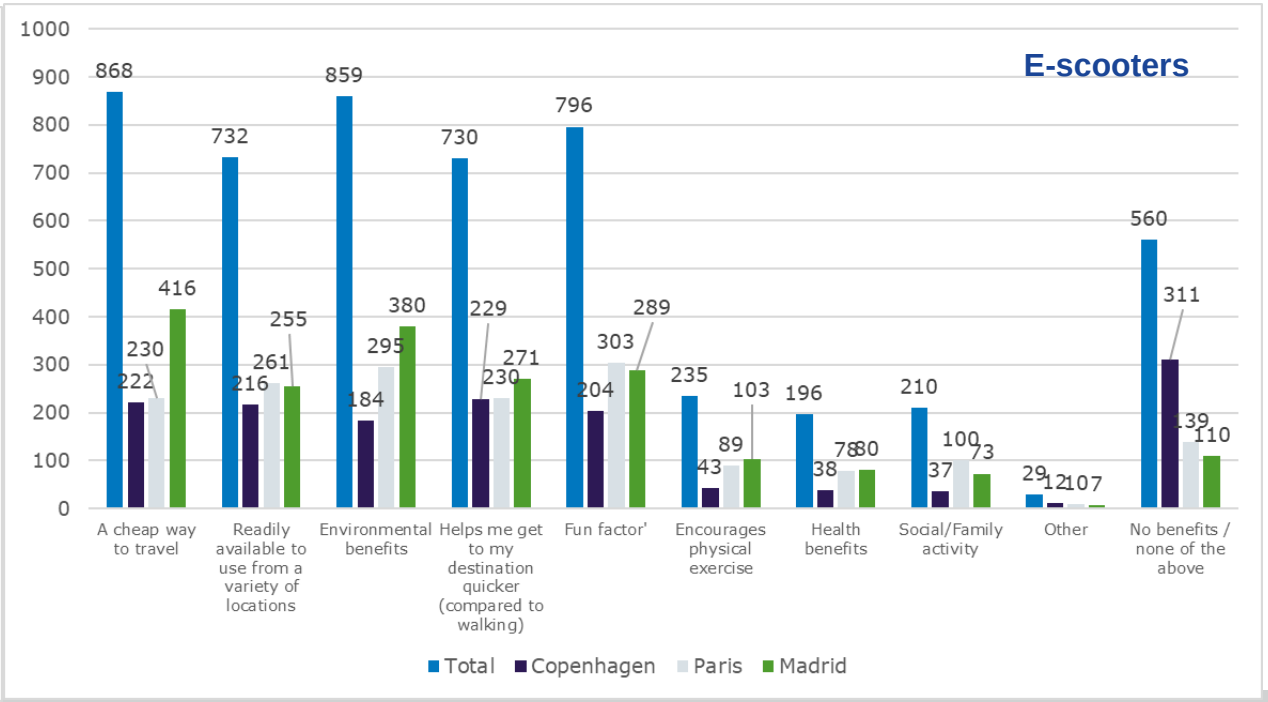


CONSUMER SURVEY: PMD USE

'What are the main benefits / attractions of using e-bikes and e-scooters?' [Respondent has not used 6+ months]

- '**Environmental benefits**' and '**A cheap way to travel**' top responses for both e-bikes and e-scooters
- Other top responses:
  - **E-bikes:** 'helps me get to my destination quicker (compared to walking)', 'readily available to use from a variety of locations', and 'encourages physical exercise'.
  - **E-scooters:** 'fun factor', 'readily available to use from a variety of locations', and 'helps me get to my destination quicker (compared with walking)'

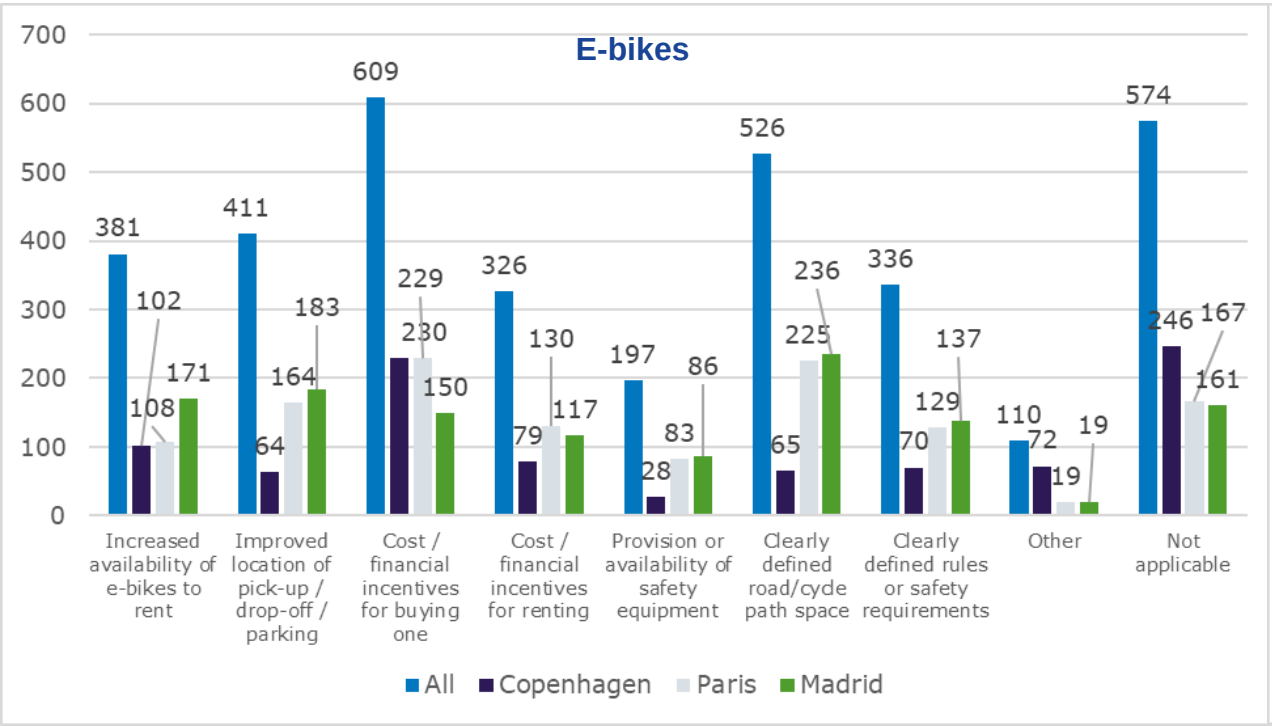


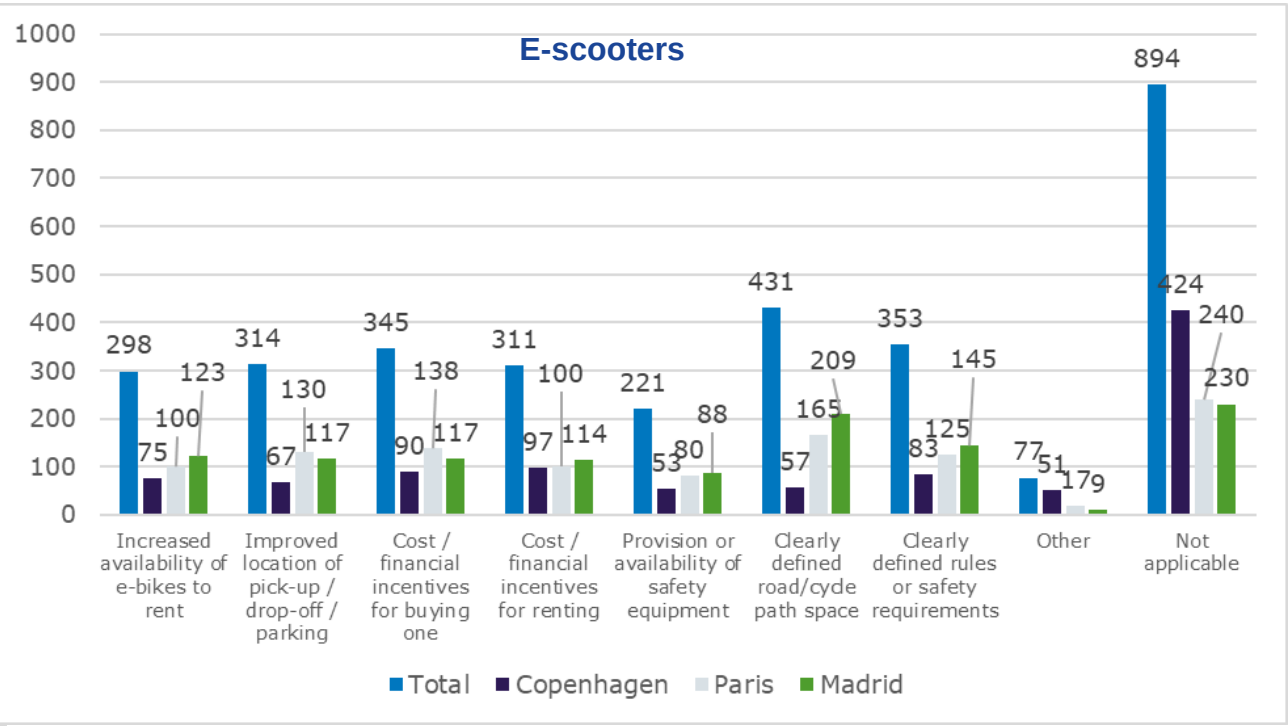


CONSUMER SURVEY: PMD USE

'What factors would encourage you to use an e-bike / e-scooter?' [Respondent has not used 6+ months]

- **E-bike:** 'cost/financial incentives for buying one', 'clearly defined road/cycle path space' and 'improved location of pick-up/drop-off/parking'
- **E-scooter:** 'clearly defined road/cycle path space', 'clearly defined rules or safety requirements', and 'cost/financial incentives for buying one'.
- A large proportion stated 'not applicable' – they would not be encouraged to use one. 28.4% for e-bikes and 43.7% for e-scooters

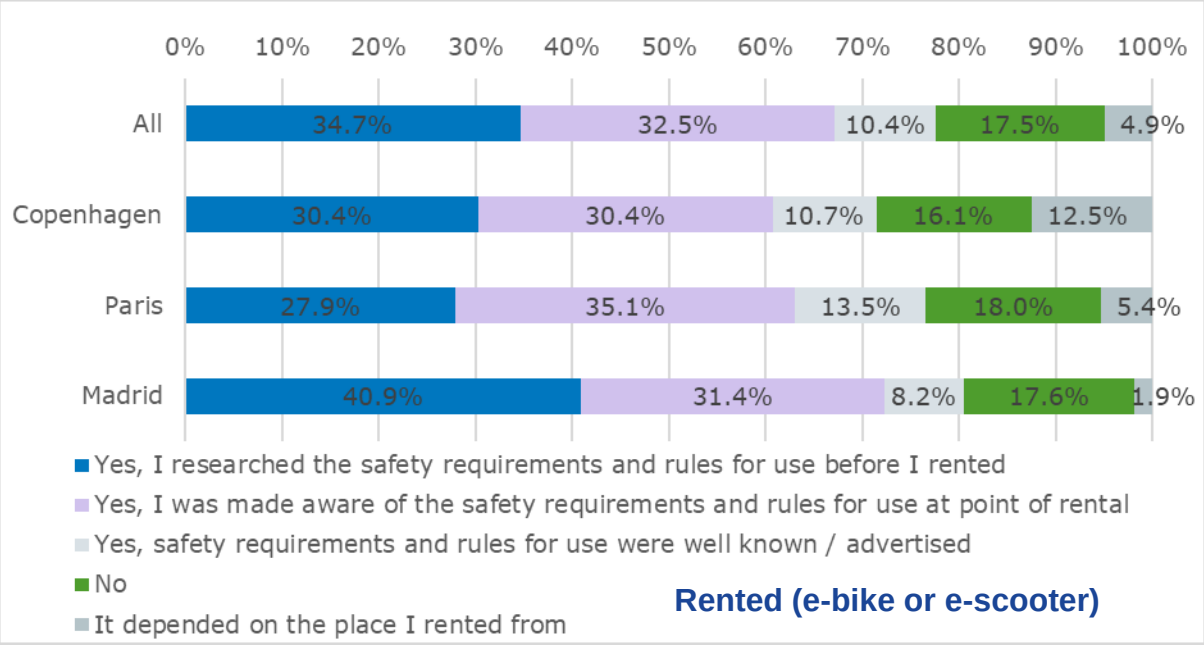




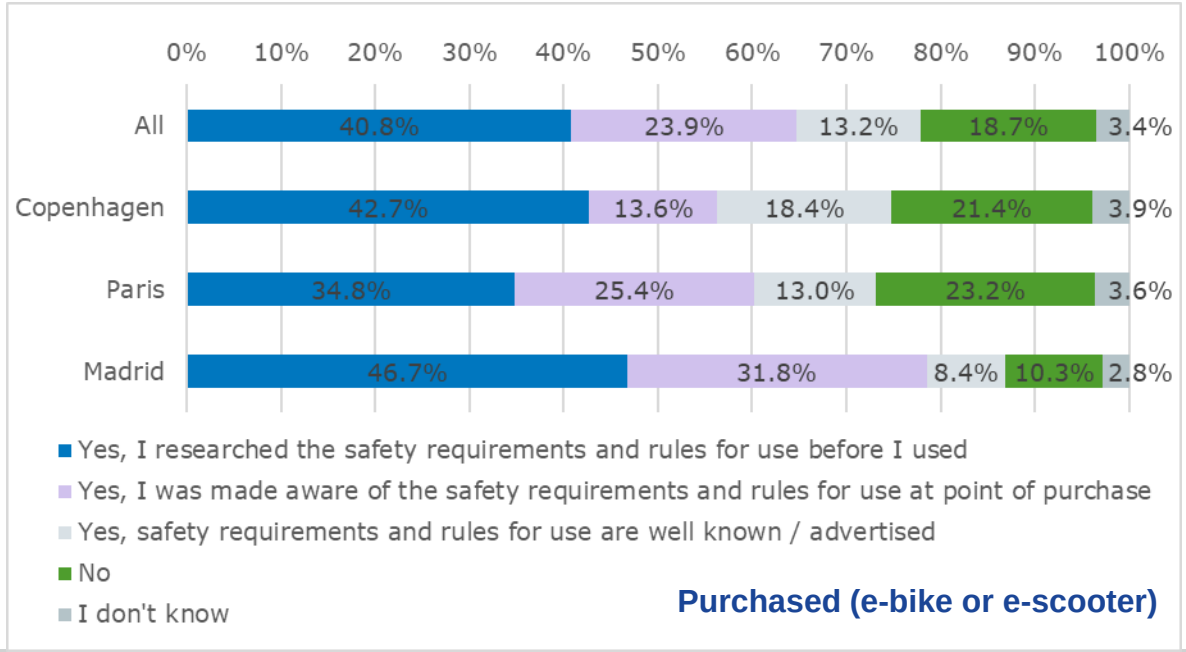
CONSUMER SURVEY: PMD LEGISLATION

'When you rented/purchased an e-bike or e-scooter in the past, were you made aware of the safety requirements and rules for use?' [Respondent has used in last 6 months]

- Rented: Majority aware of the rules – 34.7% researched, 32.5% were made aware at point of rental and 10.4% considered rules were well known. 17.5% were not made aware.
- Purchased: Majority aware of the rules – 40.8% researched, 23.9% were made aware at point of rental and 13.2.4% considered rules were well known. 18.7% were not made aware.



Rented (e-bike or e-scooter)

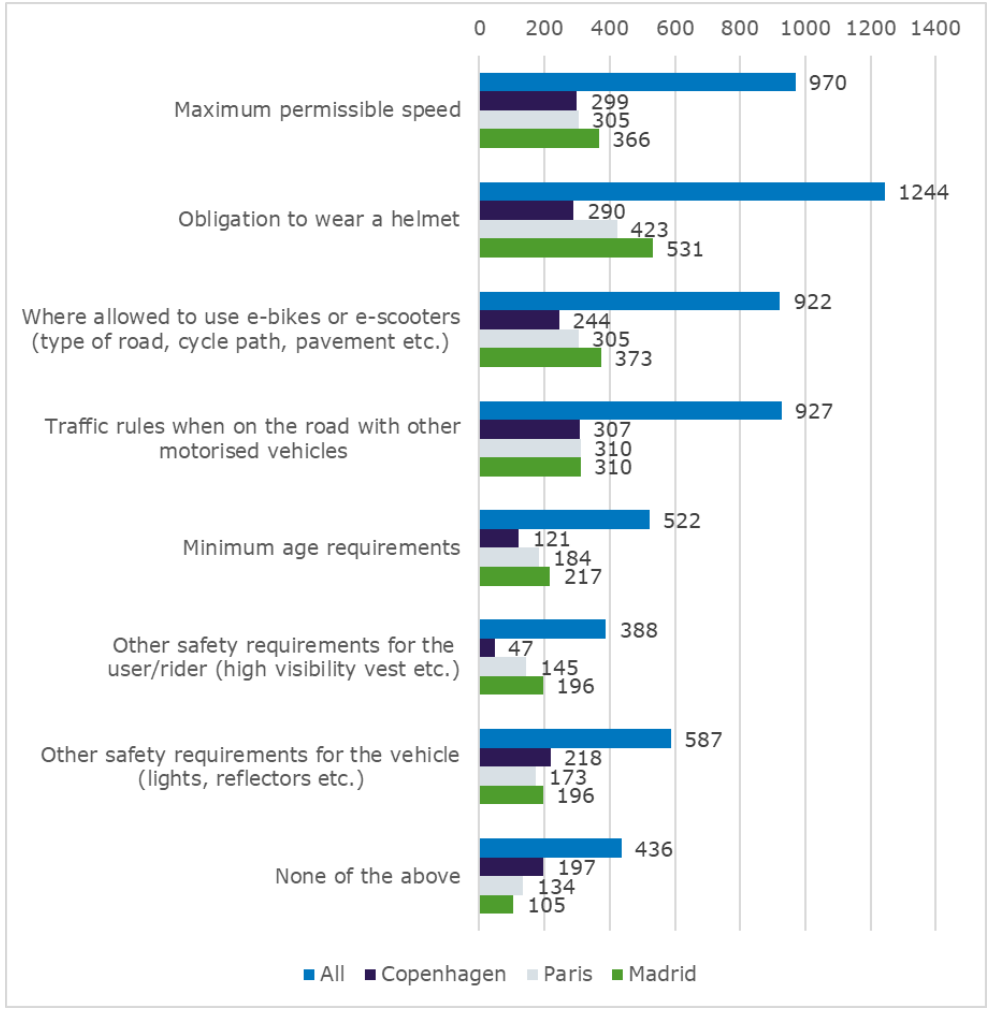


Purchased (e-bike or e-scooter)

CONSUMER SURVEY: PMD LEGISLATION

'Which of the following rules and safety regulations related to the use of e-bikes are you aware of?' [All respondents]

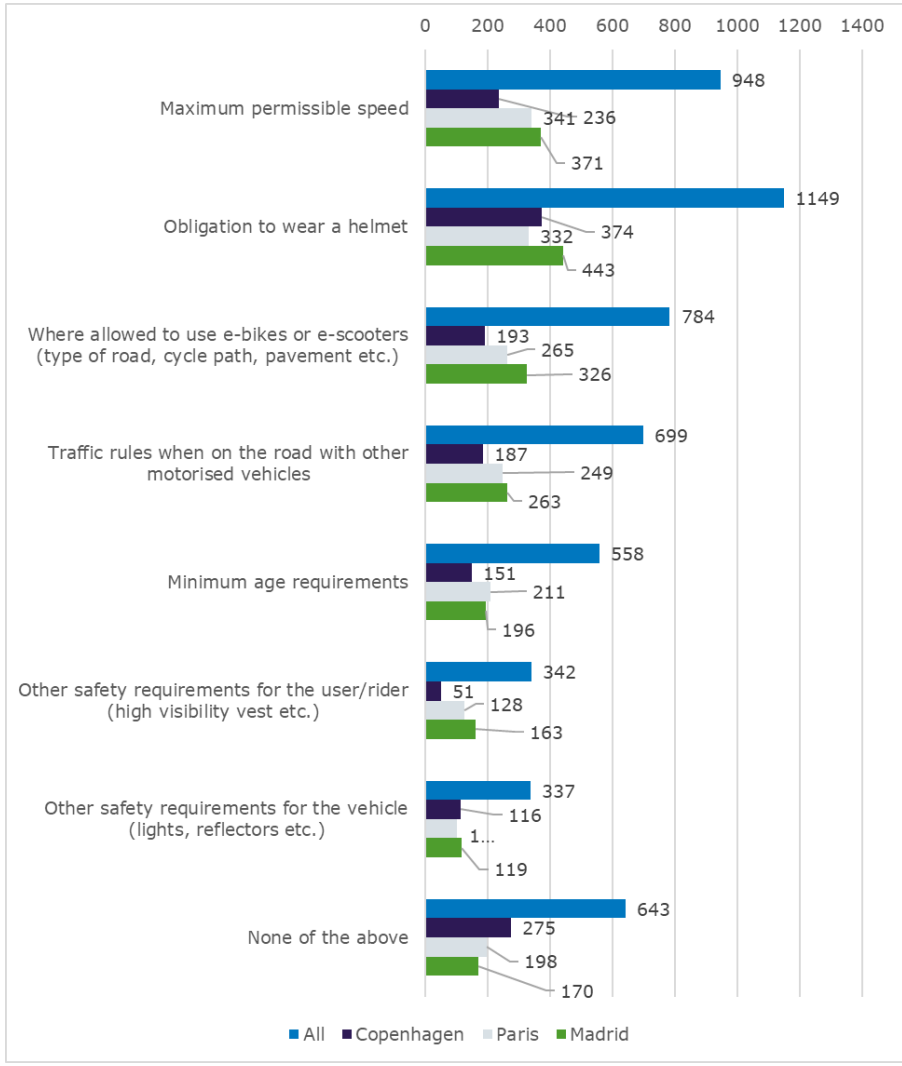
- 'Maximum permissible speed' (53.7%)
- 'Traffic rules when on the road with other motorised users' (50.8%)
- 'Obligation to wear a helmet' (49.8%)
- 'Where they allowed to use e-bikes' (48.8%)
- Only 5.7% stated that they did not know any of the rules/requirements listed.



CONSUMER SURVEY: PMD LEGISLATION

'Which of the following rules and safety regulations related to the use of e-scooters are you aware of?' [All respondents]

- 'Obligation to wear a helmet (56.6%)
- 'Maximum permissible speed' (48.7%)
- 'Where allowed to use e-scooters' (46.9%)
- 'Traffic rules when on the road with other motorised users' (45.4%)
- Only 4.2% stated that they did not know any of the rules/requirements listed
- In most cases, approximately 50% or more of users (e-bikes and e-scooters) are not aware of safety requirements and rules for use

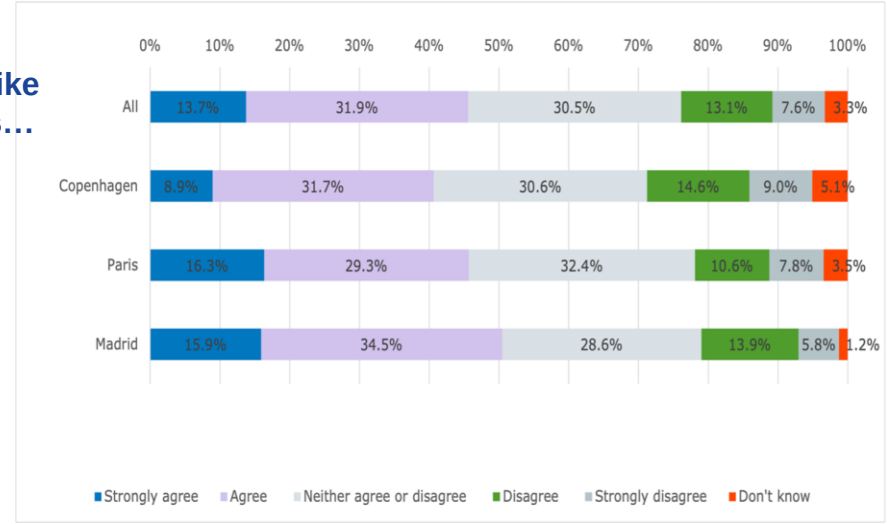


CONSUMER SURVEY: SAFETY

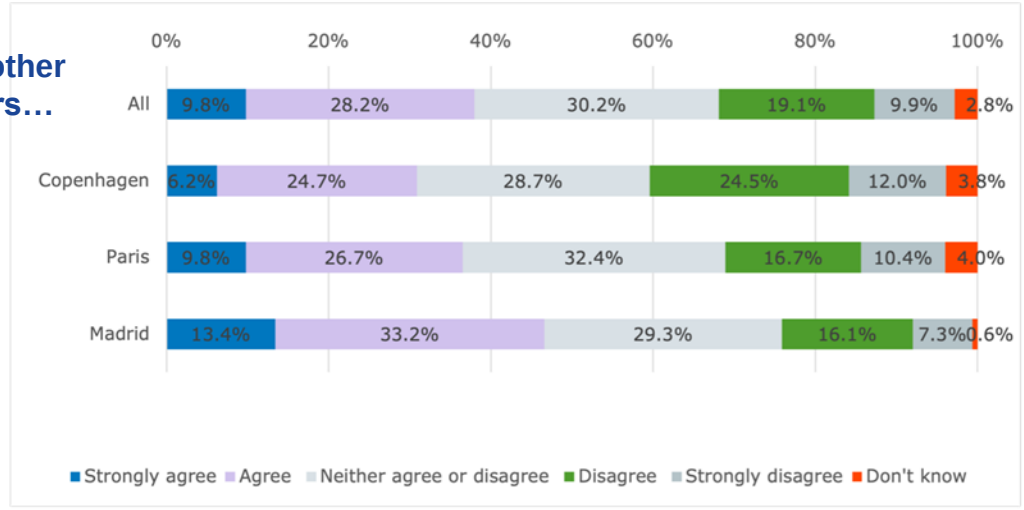
'Do you agree that e-bikes are safe for…riders/users / other motorised road users / pedestrians / ?' [All respondents]

- There is a higher level of agreement that e-bikes are safe for e-bike users/riders, other road users and pedestrians.
- The majority of respondents (45.6%) agree that e-bikes are safe for riders/users.
- 38% agree that e-bikes are safe for other road users
- 36.7% agree that they are safe for pedestrians.

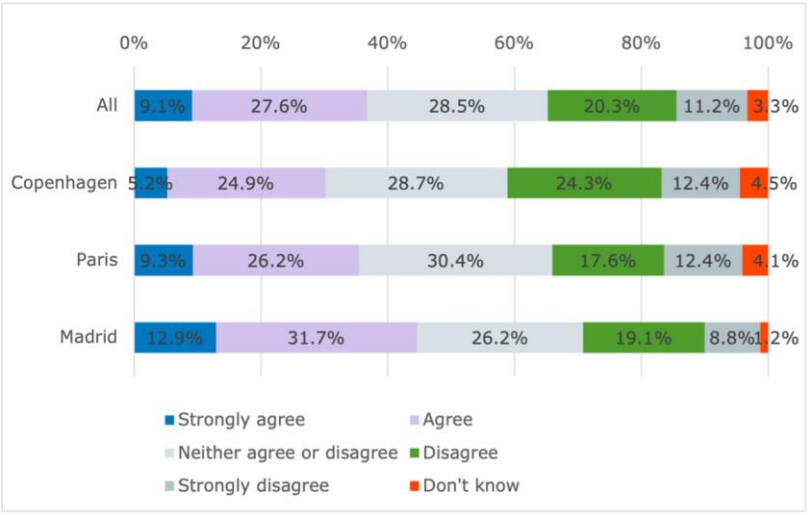
Safe for e-bike users/riders…



Safe for other road users…



Safe for Pedestrians…

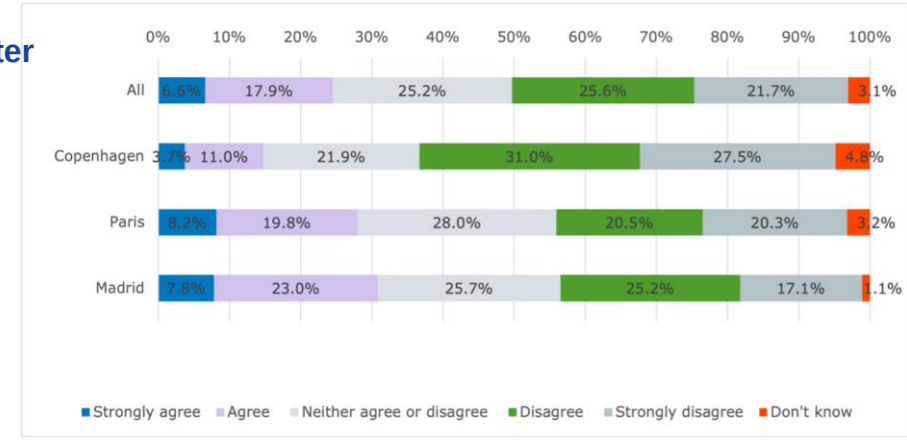


CONSUMER SURVEY: SAFETY

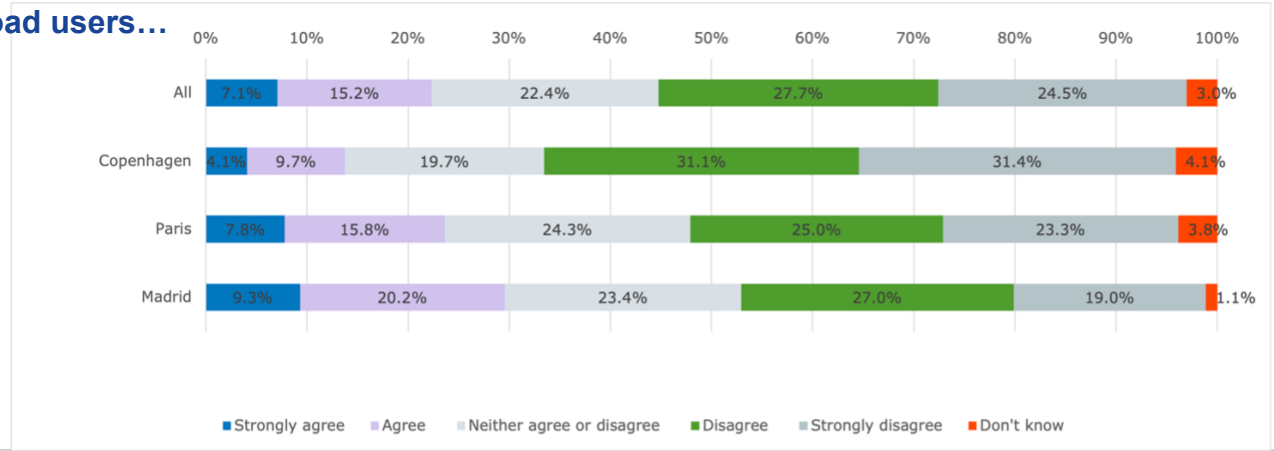
'Do you agree that e-scooters are safe for…riders/users / other motorised road users / pedestrians / ?' [All respondents]

- Respondents tend to disagree that that e-scooters are safe for e-scooter users/rider, other motorised users and pedestrians
- The majority of respondents (47.3%) disagree that e-scooters are safe for riders/users
- There is higher disagreement with the statement 'e-scooters are safe for other road users' (52.2%) and e-scooters are safe for pedestrians (55.9%) (versus 20.9% who agree that they are safe)

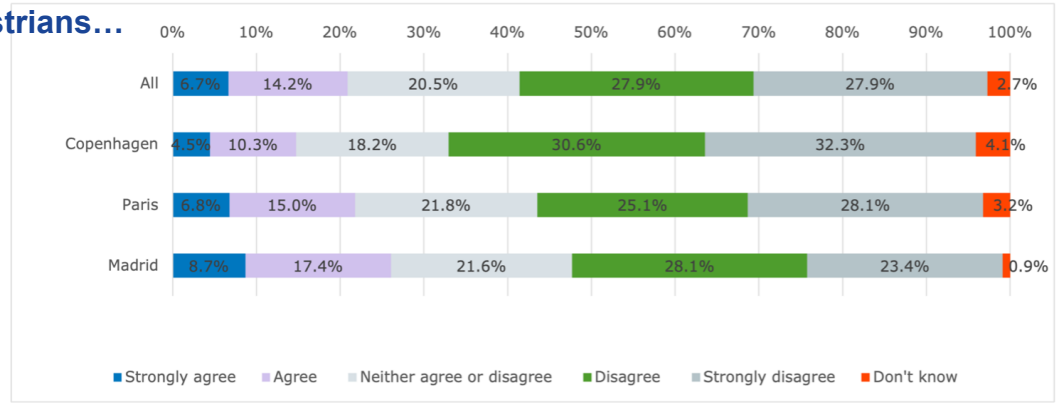
Safe for e-scooter users/riders…



Safe for other road users…



Safe for Pedestrians…

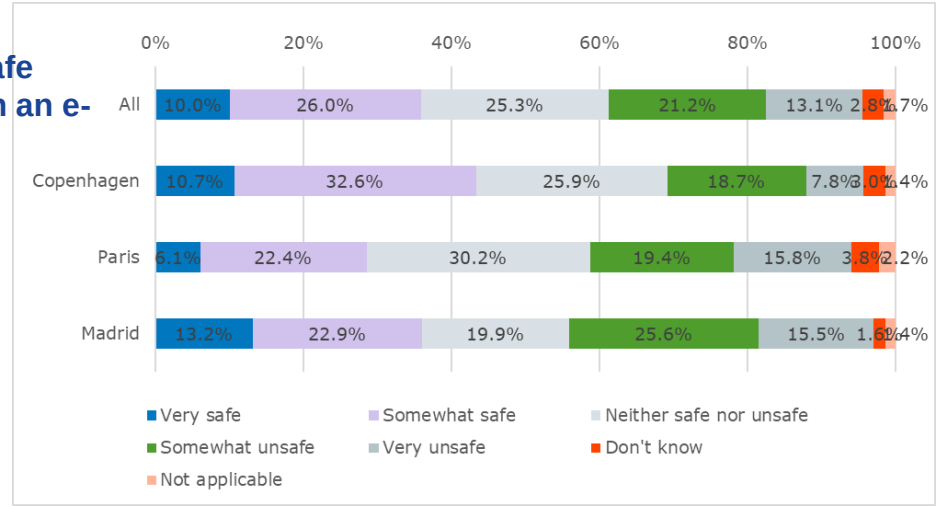


CONSUMER SURVEY: SAFETY

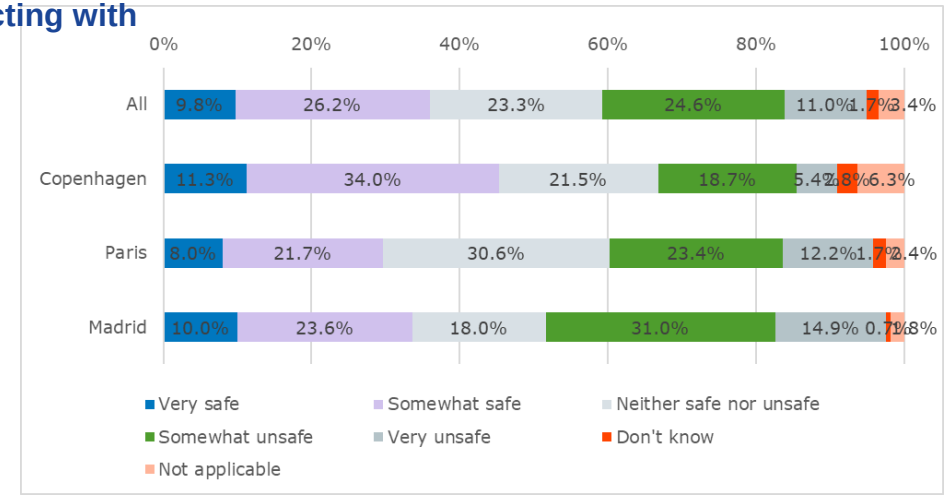
'As a pedestrian / motorised roads user / e-scooter user - how safe do you feel interacting with e-bikes?' [All respondents]

- 36% of pedestrians feel safe interacting with **e-bikes**, versus 34% that do not
- 36% of drivers of a motorised vehicle indicated that they feel safe when interacting with e-bikes, although 35.6% indicated they did not feel safe
- 47.2% of e-scooter riders indicated that they feel safe when interacting with e-bikes, although 28% indicated they did not feel safe

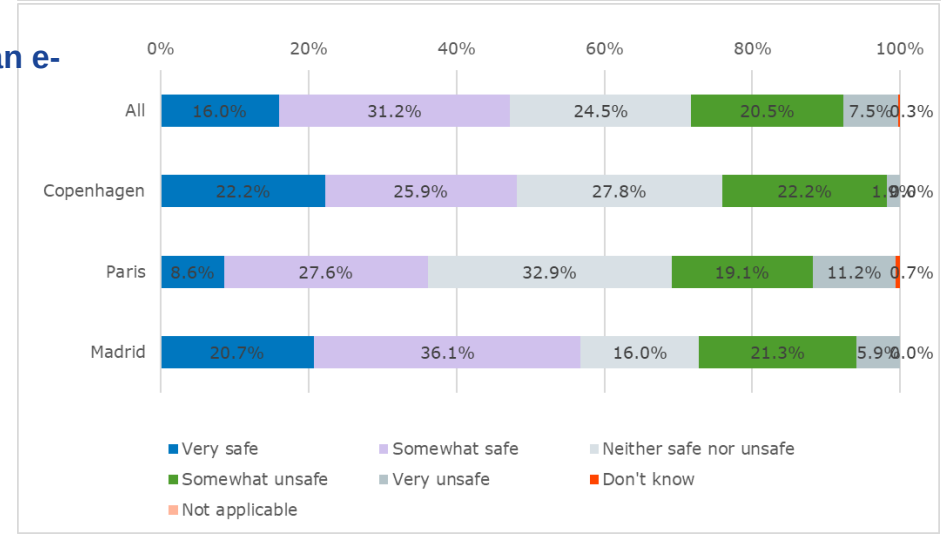
Pedestrian – safe interacting with an e-bike



Other road user – safe interacting with an e-bike



E-scooter – safe interacting with an e-bike

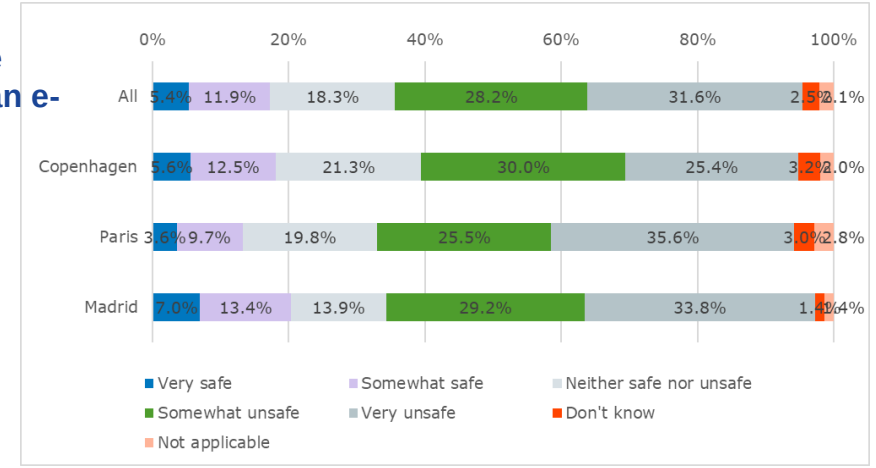


CONSUMER SURVEY: SAFETY

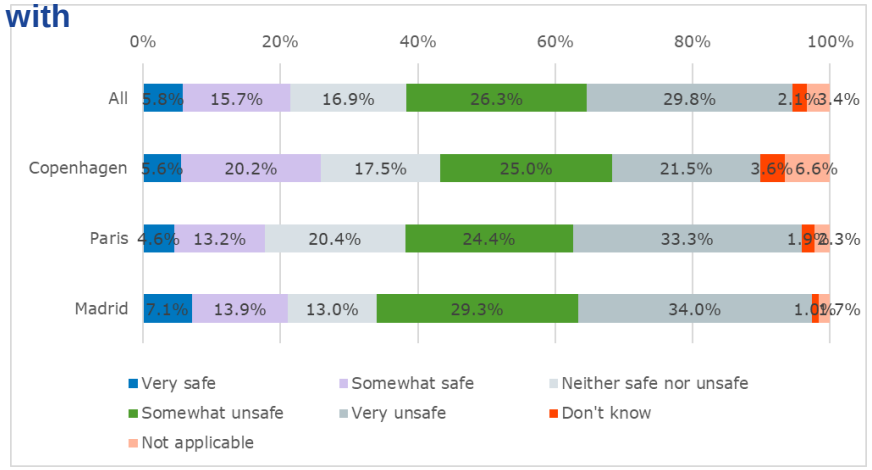
'As a pedestrian / motorised roads user / e-bike user - how safe do you feel interacting with e-scooters?' [All respondents]

- Pedestrians feel least safe when interacting with **e-scooters** (59.8%– only 17.3% indicated that they felt safe).
- Users/riders of e-bikes feel least safe when interacting with e-scooter users/riders (36.1%– 38.9% indicated that they felt safe).
- 21.5% of drivers of a motorised vehicle indicated that they feel safe when interacting with e-scooters, although 56.1% indicated they did not feel safe

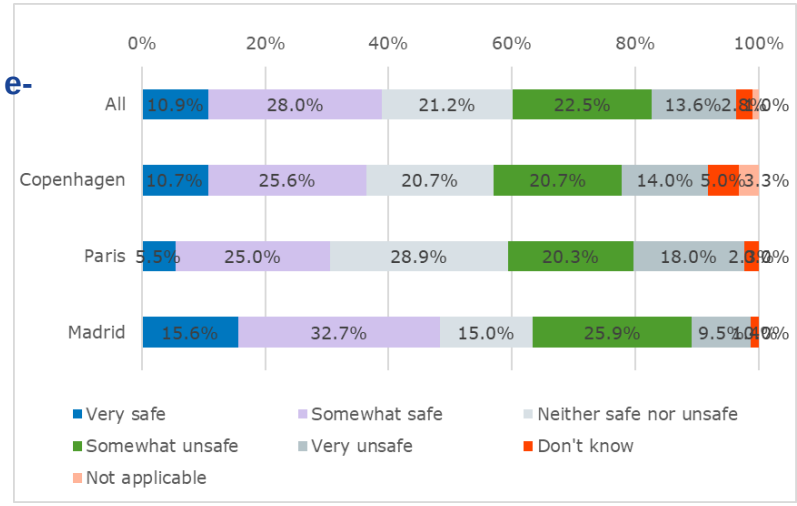
Pedestrian – safe interacting with an e-scooter



Other road user – safe interacting with an e-scooter



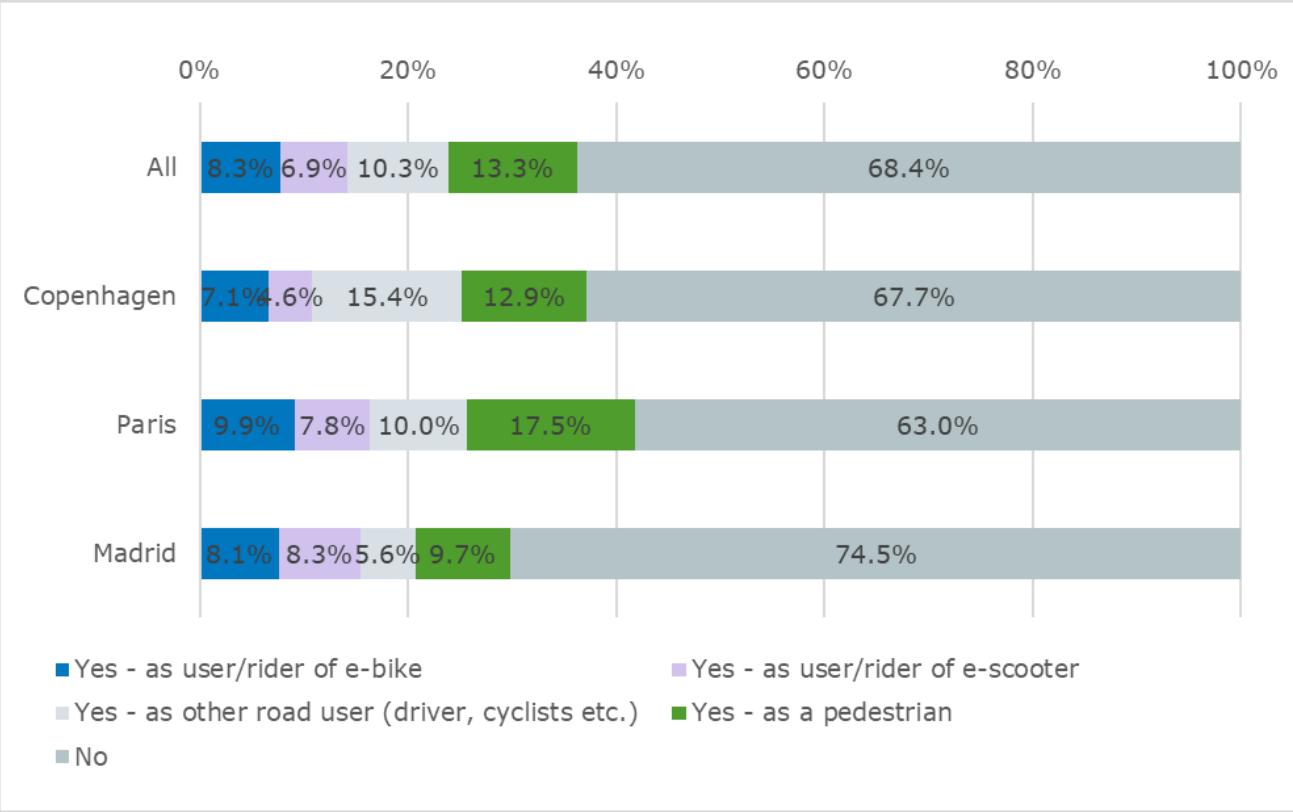
E-bike – safe interacting with an e-scooter



CONSUMER SURVEY: SAFETY

'Have you ever been involved in an accident/near-miss with an e-bike or an e-scooter?' [All respondents]

- 8.4% had been involved as a user/rider of an e-bike, 6.9% as a user/rider of an e-scooter, 10.3% as another road user and 13.3% as a pedestrian.

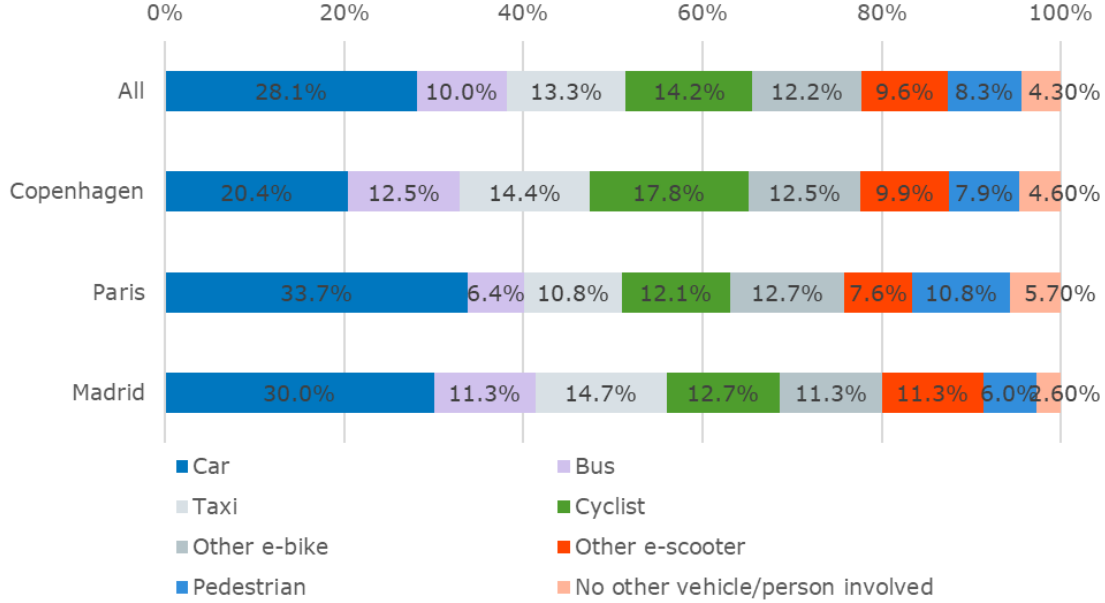


CONSUMER SURVEY: SAFETY

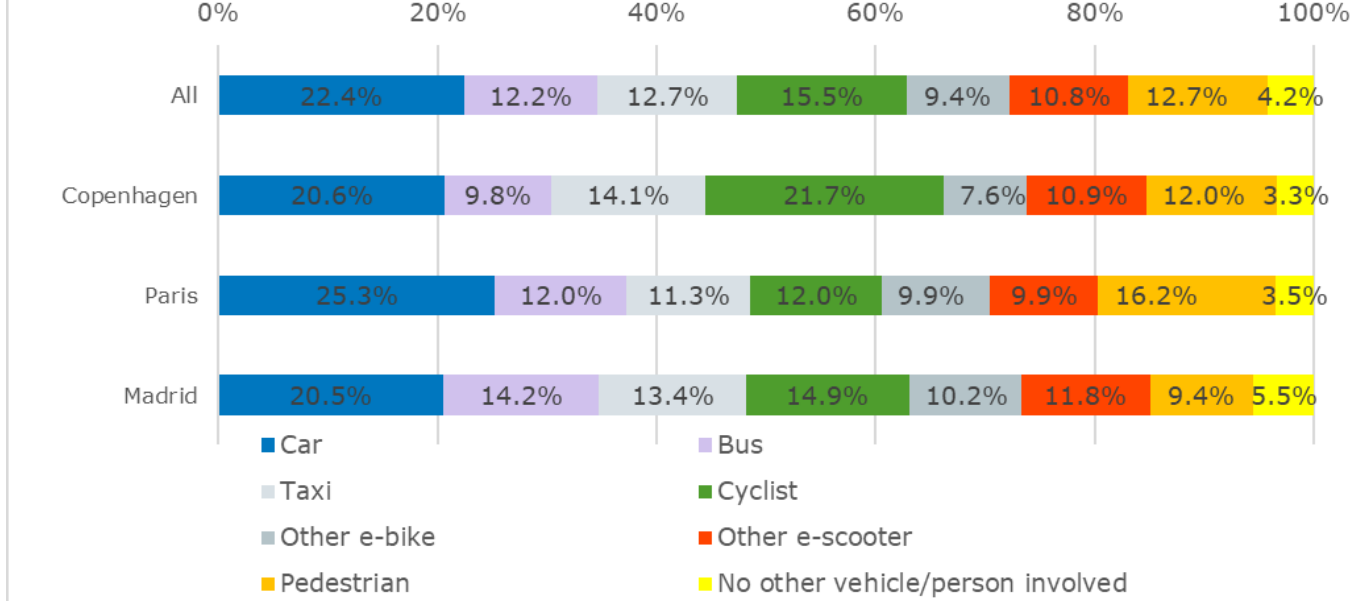
'*Who was the accident/near miss with?*' [Users/riders of e-bikes/e-scooters – answered 'yes' to previous question]

- Of the 202 e-bike users that had been in an accident, 28.1% was with a car, 14.2% with a cyclist, 13.3% with a taxi, 12.2% with another e-bike, 12.5% with a bus, 9.9% with an e-scooter and 8.3% with a pedestrian. 4.3% of accidents did not involve another vehicle/person
- Of the 167 e-scooter users that had been in an accident, 22.4% was with a car, 15.5% with a cyclist, 12.7% with a pedestrian, 12.7% with a taxi, 12.2% with a bus, 10.8% with an e-scooter and 9.4% with an e-bike, 4.2% of accidents did not involve another vehicle/person.
- Higher proportion of e-bike accidents involved a car, potentially due to their position on the main carriageway. However, a higher proportion of e-scooter accidents involved pedestrians (12.7%) compared to e-bikes.

E-bike users/riders



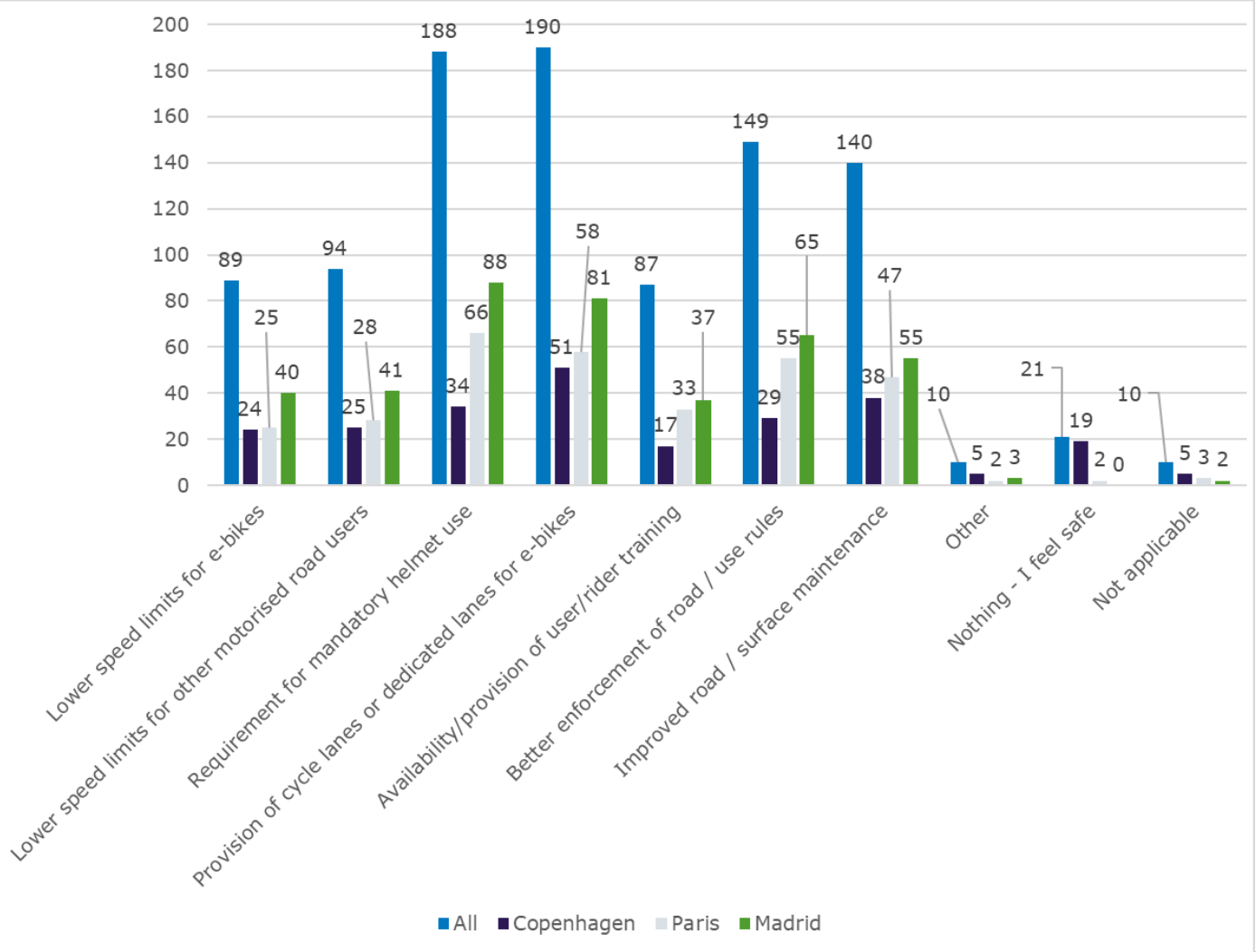
E-scooter users/riders



CONSUMER SURVEY: SAFETY

'As a user/rider of e-bikes, what could be done to make you feel safer?' [Users/riders of e-bikes]

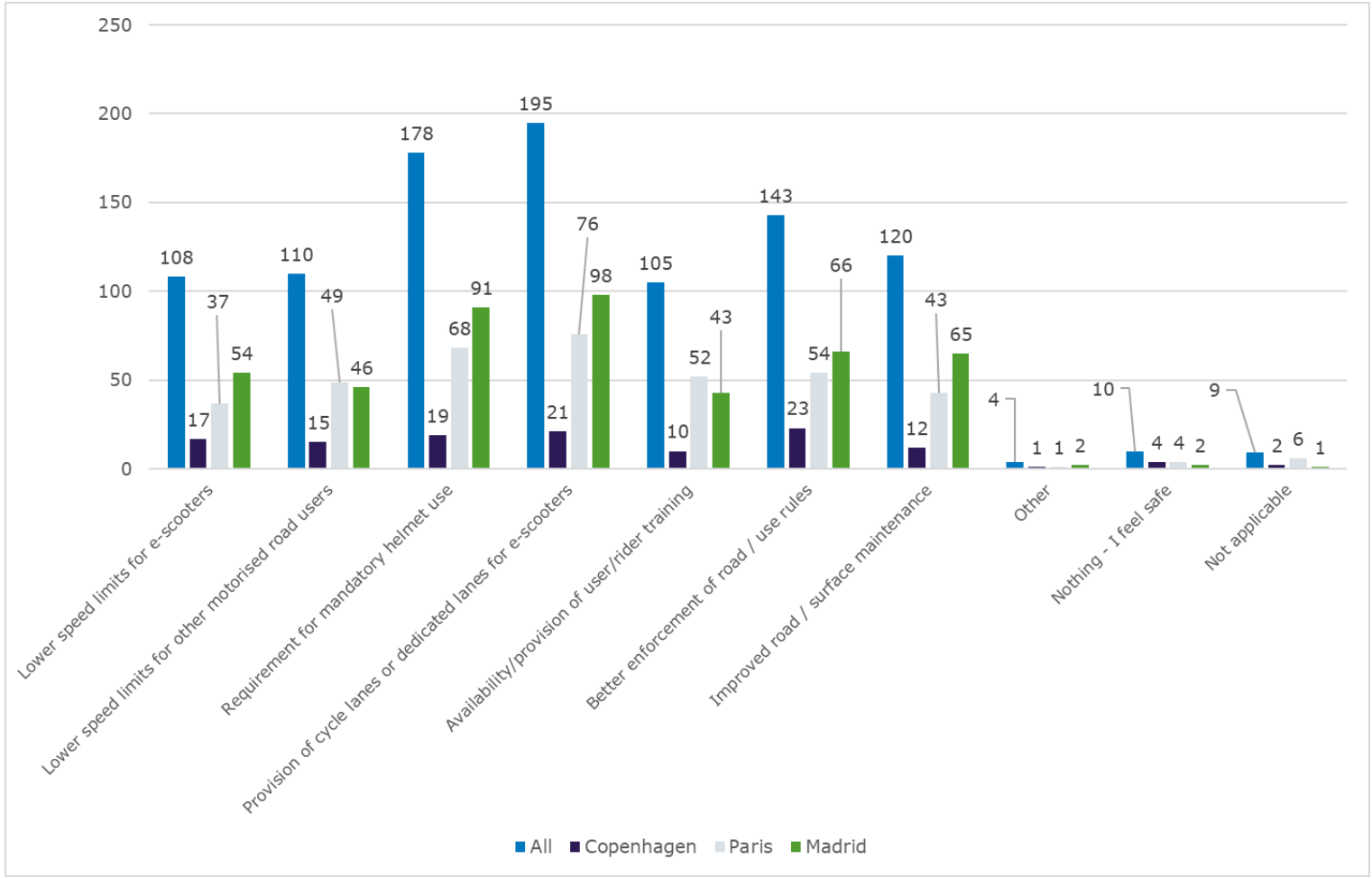
1. Provision of dedicated cycle lanes for e-bikes
2. Requirements for mandatory helmet use
3. Better enforcement of road/use rules
4. Improved road/surface maintenance
5. Lower speed limits for other motorised road users



CONSUMER SURVEY: SAFETY

'As a user/rider of e-scooters, what could be done to make you feel safer?'
[Users/riders of e-scooters]

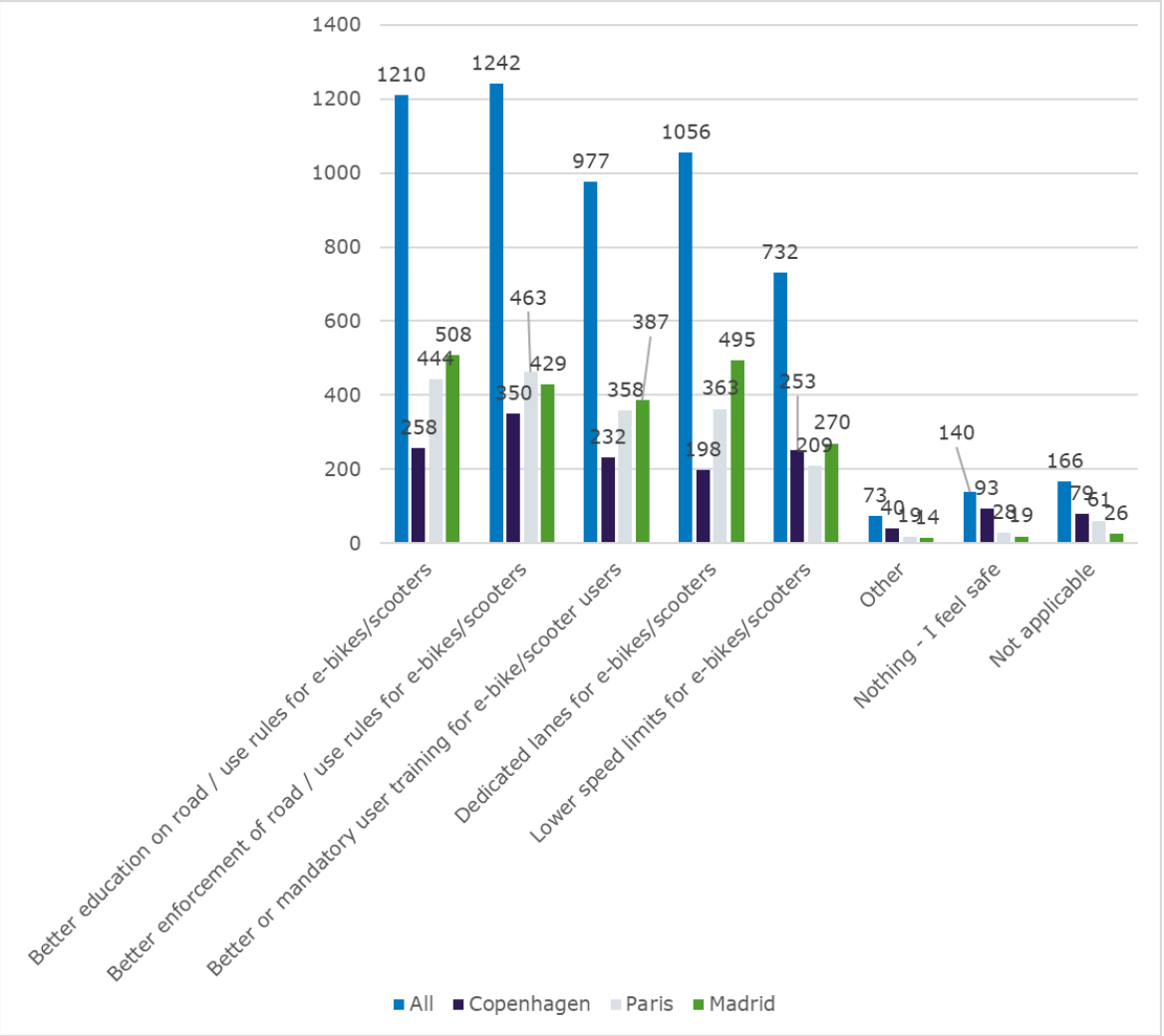
1. Provision of dedicated cycle lanes for e-scooters
2. Requirements for mandatory helmet use
3. Better enforcement of road/use rules
4. Improved road/surface maintenance
5. Lower speed limits for other motorised road users



CONSUMER SURVEY: SAFETY

'As a pedestrian or a users of another vehicle, what could be done to make you feel safer?' [All respondents]

1. Better enforcement of road/use rules
2. Better education on road/use rules
3. Dedicated lanes for e-bikes and e-scooters
4. Better or mandatory user training for e-bike/e-scooter users
5. Lower speed limits for e-bikes / e-scooters

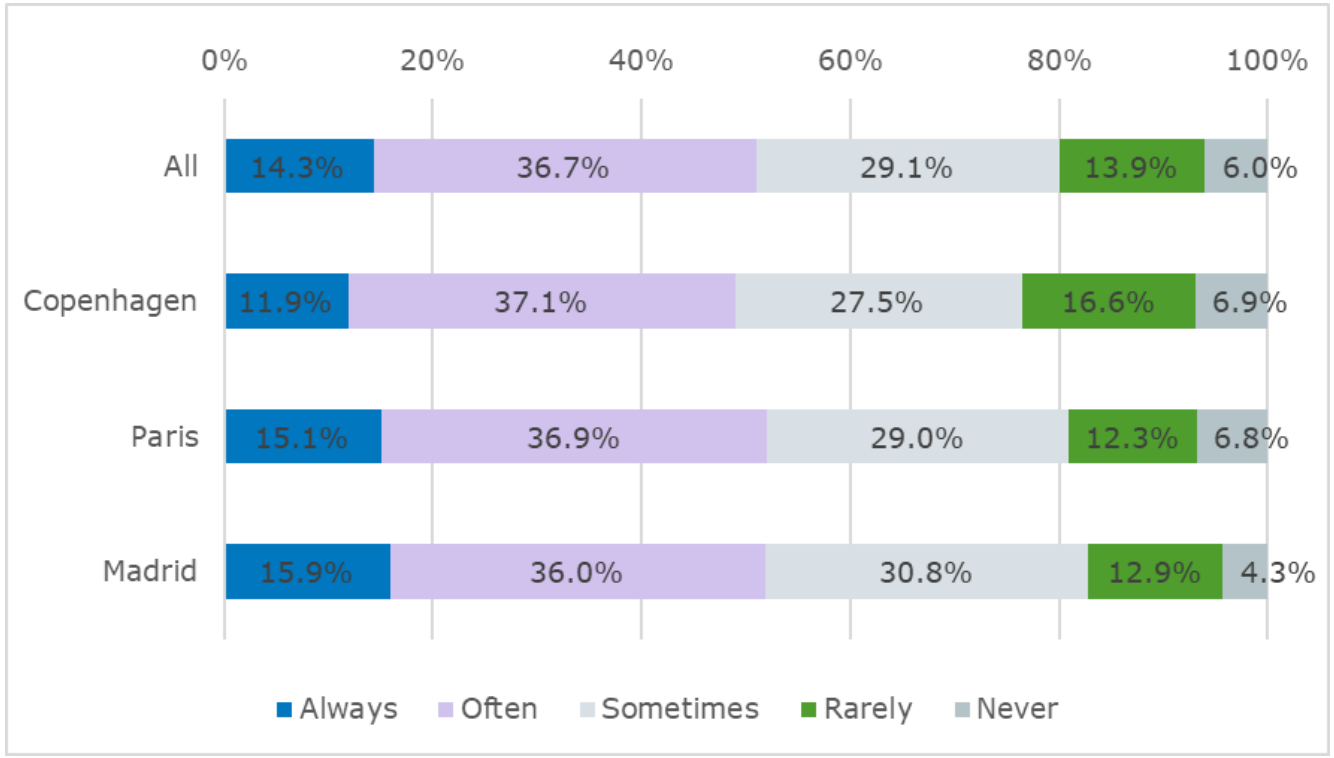


CONSUMER SURVEY: ENVIRONMENT

'How often do you take environmental considerations into account when choosing your mode of transport?'
[All respondents]

- The majority of respondents (51%) always/often take environmental considerations into account when choosing their mode of transport
- This increases to 78.6% for frequent users of PMDs (several times/week)
- Less than 20% rarely or never take it into account (6.8% for frequent PMD users)

- ***ADAC (2022) survey:*** *'How important is it to you that your own traffic behaviour is climate friendly?' 27% responded very important and 33% responded important (e-scooter users)*



CONSUMER SURVEY: ENVIRONMENT

Cityscape and public space

- 25.5% of respondents agreed that **e-bikes** have a negative impact on cityscape and public space in their city.
- 43% of respondents agreed that **e-scooters** have a negative impact on cityscape and public space in their city.

- Parking issues relating to e-scooter use lead to higher rates of dissatisfaction of the impact they have on the cityscape compared to e-bikes.

Use of PMDs in urban areas and modal shift

- There is a high level of agreement that **e-bikes** are better for journeys in built up areas (57.1%), that e-bike trips make short trips more convenient (64.5%) and that they will help to improve air quality in towns and cities (69%). 63.8% respondents agree that e-bikes are a better substitute for car trips in towns and cities, and that they will reduce congestion (55.2%).
- However, 49.9% respondents agree that e-bikes are a better substitute for PT in towns and cities, and 37.9% for walking.
- There is a high level of agreement that **e-scooters** are better for journeys in built up areas (47.6%), that e-scooter trips make short trips more convenient (52.6%) and that they will help to improve air quality in towns and cities (56.4%). 45.2% respondents agree that e-scooters are a better substitute for car trips in towns and cities, and that they will reduce congestion (42.4%).
- 36% respondents agree that e-scooters are a better substitute for PT in towns and cities and 31.9% for walking.
- Respondents recognise that journeys by e-bikes and e-scooters in towns and cities can be beneficial in terms of a substitute for personal car trips, including reducing congestion and realising environmental benefits (improved air quality).
- E-scooters to a lesser extent, perhaps due to the lower trip distances typically covered compared to e-bikes.
- However, respondents also recognise that e-bikes and e-scooters are sometimes regarded as a better substitute for walking trips and public transport trips.

CONTENTS

POLICY RECOMMENDATIONS

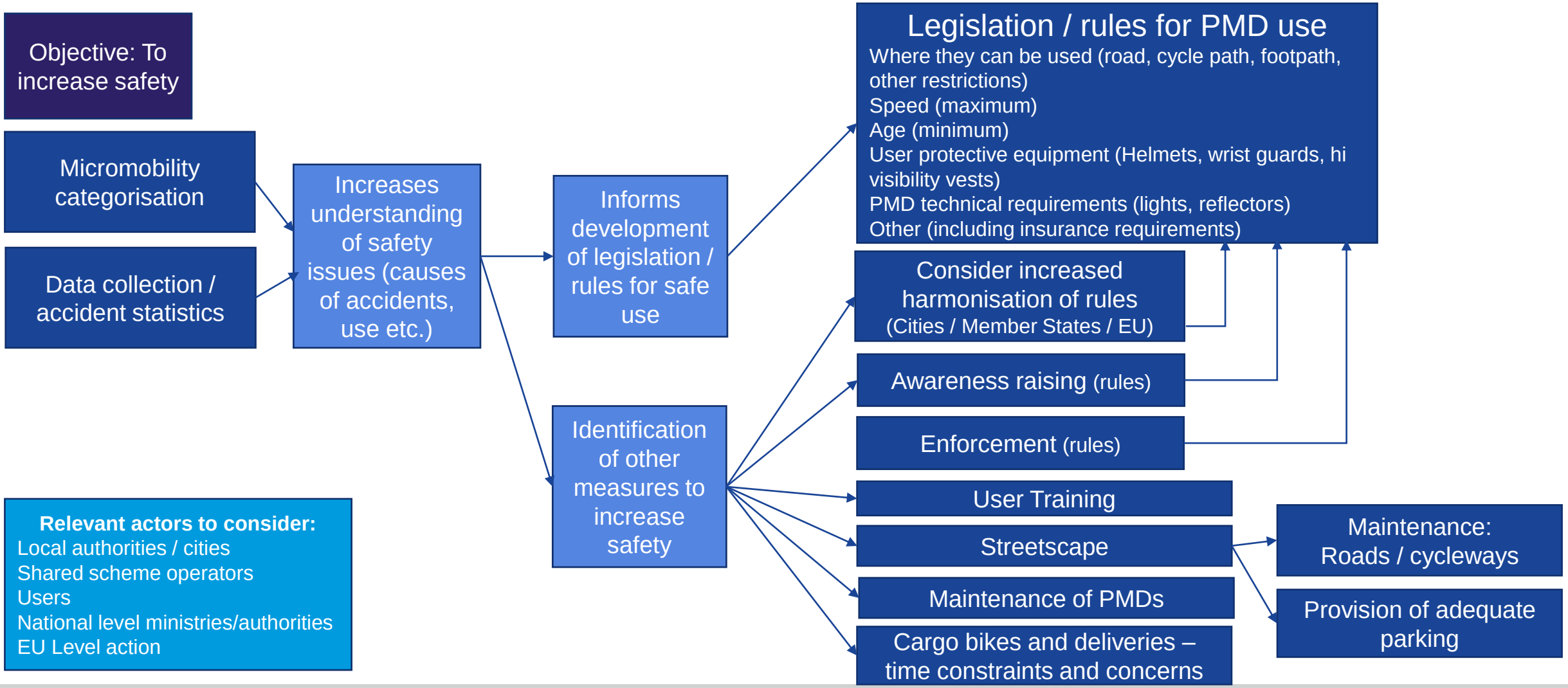
Approach:

- The following sources have been utilised in the development of policy recommendations:
  - Desk research / evidence review:
    - Key reports, studies and data on issues and challenges
    - Desk research into PMD use in three case study EU cities
  - Consumer survey analysis:
    - Findings and perceptions of consumers in three case study EU cities

- Potential actors involved in the implementation of policy recommendations have been identified, and are indicated as follows:

Relevant implementation actors			
EU level		Law enforcement authorities	
National authorities		PMD manufacturers	
Local authorities		Businesses	
PMD Operators (shared schemes)			

POLICY RECOMMENDATIONS OVERVIEW: SAFETY



POLICY RECOMMENDATIONS OVERVIEW: ENVIRONMENT

Objective: To contribute towards local environmental benefits through increased PMD use (mode shift from private car)

Objective: To minimise negative environmental impacts of PMD use

Further research – PMD use, mode shift, perceptions

Development of full LCA for PMDs

Increased understanding of environmental impacts of PMD use

- Setting clear PMD use goals
- Promoting PMD use as a last-mile solution
- Multimodal ticketing – PT, e-scooter/e-bike rental
- Addressing other barrier to use – safety, how to use etc.
- Communicating environmental credentials of PMDs
- Collection/redistribution (shared schemes)
  - Time of day
  - Type of vehicle
- Charging / battery swapping (shared schemes)
- Maintenance / repair/ reuse: E-bikes / e-scooters

Relevant actors to consider:
Local authorities / cities
Shared scheme operators
Users
National level ministries/authorities
EU Level action

POLICY RECOMMENDATIONS

Defining ‘Micromobility’ and collection of data/statistics

- There is currently a lack of a common definition of ‘Micromobilty’ at all levels – International, EU, national and local.
- Micromobility accident and safety data is not consistently collected in EU Member States, either on a national, city, nor operator basis [Literature, case studies].
- Where data is collected, there is little differentiation between types of bicycle (e.g. EPAC, speed e-bike, cargo bike etc.), and very few dedicated e-scooter statistics.
- Reports and academic studies have utilised hospital, self-reported or insurance data to examine accidents related to PMD use (which tend to focus on e-scooters) [Literature]
- Lack of data and statistics prohibits a full understanding of the safety concerns relating to Micromobility, and subsequently how specific safety concerns could be addressed to improve safety for users and those they interact with [Literature].
- For example, e-bike crashes have seen a significant increase, but so have sales. Assessment of accident rates relies on data for both the incidents and the underlying volume of riders, which is not routinely collected in most countries [Literature].

Lessons from case study cities

Copenhagen: National level statistics (Denmark) are collated and published on injured/killed in road traffic accidents, including a ‘bicycle’ category. More detailed data is collected (not public), which includes a category for ‘e-bike’. However, ‘e-scooters’ are not represented in the datasets. Local level data/statistics are not routinely collected.

Madrid: National level statistics (Spain) report on accidents including for ‘vehicles of personal mobility’ (VPM) and users of bicycles, although this is not further elaborated on in terms of ‘e-bike’ vs traditional pedal bike. City-level statistics (registered by the police) include fatalities derived from ‘fall from bike’, but does not define whether this was an e-bike. For all accidents in Madrid, there are categories including EPAC (assisted pedaling), patinete (scooter) and VMU electricos (electric vehicles of urban mobility).

POLICY RECOMMENDATIONS

Defining ‘Micromobility’ and collection of data/statistics

Recommendations	Implementation
It is recommended that ‘Micromobility’ modes are more clearly defined, initially at the EU level – with common definitions used nationally or internationally.	European Commission National & local authorities
Both accident statistics and usage rates for Micromobility modes should be collected and recorded more routinely.	Local transport authorities (support and advice from national transport authorities) PMD operators (shared schemes)
Accident statistics should differentiate between Micromobility modes where possible (using agreed definitions), including EPAC, speed e-bike, cargo bike, and e-scooter.	
This will enable both policy makers and operators to understand in more detail the causes of accidents/near misses, the individuals affected and potentially identify appropriate measures to address identified safety concerns.	

POLICY RECOMMENDATIONS

Review of legislation / rules for use – Addressing safety concerns

- Legislation and rules for use are typically related to ensuring the safe use of PMDs and reducing accidents (for both users/riders of PMDs and others), including:
  - Where PMDs can be used (road type, segregation etc.)
  - Maximum permitted speed
  - Required protective safety equipment
  - PMD technical requirements [Literature]
- The following actions were all cited as those that would make e-bike/e-scooter users/riders and pedestrians feel safer [survey]:
  - Better enforcement of the road rules
  - Where possible, segregation/dedicated lanes for e-bike/e-scooters
  - Reduced speed limits for e-bikes/e-scooters
  - Recommended or mandated use of protective equipment (particularly helmets for e-scooters – tend to be more head injuries).
  - Appropriate parking from a safety perspective [see *'Parking'*]

Lessons from case study cities

Copenhagen: Mandatory helmet use for e-scooter users since January 2022. Operator TIER provides helmets for each rental trip, helping users meet the requirements to wear one.

Madrid: Helmet use of e-scooters became mandatory for users.

Paris: Reduction of speed limits in selected areas (built-up, busy streets) and introduction of geofencing to enforce the lower speed limits.

POLICY RECOMMENDATIONS

Review of legislation / rules for use – Addressing safety concerns

Recommendations	Implementation
Improved collection of Micromobility-specific safety and accident data should be promoted, to enable policy makers to make informed decisions regarding the review of legislation and rules for PMD use. • [See '*Defining Micromobility and collection of data and statistics*']	European Commission National & local authorities
Increase harmonisation of legislation/rules where possible, in order to reduce confusion and increase user understanding.	National & local authorities
Ensure any changes to legislation and/or rules are well communicated to PMD users. • [See *'Raising awareness*']	Local transport authorities PMD operators (shared schemes)
Encourage appropriate enforcement of legislation and rules, resulting in increased awareness and safety.	Local transport authorities PMD operators Law enforcement authorities

POLICY RECOMMENDATIONS

Parking for PMDs – Safety concerns

- Shared PMDs (primarily e-scooters) are often inconsiderately parked (or discarded) on footpaths, cycle paths and other shared-areas in towns and cities. [Literature]
- Poor-parking of PMDs was found to contribute to the cause of e-scooter accidents, leading to the injury of others, in particular pedestrians, elderly, blind, disabled. [Literature]

Parking for PMDs - Environmental concerns

- Presence/parking of PMDs can be considered to have a negative effect on the visual appeal of towns and cities
- One quarter of respondents agreed that **e-bikes** have a negative impact on cityscape and public space in their city [Survey]
- 43% of respondents agreed that **e-scooters** have a negative impact on cityscape and public space in their city [Survey]
- Parking issues relating to e-scooter use lead to higher rates of dissatisfaction of the impact they have on the cityscape compared to e-bikes [Survey]

Lessons from case study cities

Copenhagen: Parking of e-scooters a particular problem in Copenhagen. Since reintroduction in 2021, there are strict designated parking areas around the city. Parking guards have been employed to enforce appropriate parking, issuing fines for operators for e-scooters parked outside of designated zones. Users can also only end their rentals in designated parking zones.

Paris: Use of geofencing to ensure e-scooters can only be parked in designated parking areas.

POLICY RECOMMENDATIONS

Parking for PMDs – Safety and environmental concerns

Recommendations	Implementation
Appropriate provision and enforcement of correct parking for PMDs should be a priority.	
PMD users need to be informed about correct parking. • [See '*Raising awareness*']	Local transport authorities PMD operators (shared schemes) 
Measures to encourage appropriate PMD parking should be employed, including: • Fines for users who park inappropriately. • Additional fines for operators where users park inappropriately – providing an incentive to ensure appropriate parking/enforcement. • Local authorities should consider removal/confiscation of units that are parked inappropriately.	Local transport authorities PMD operators (shared schemes) 
Using of a range of enforcement methods should be considered (by operators / local authorities), including: • Increased monitoring and enforcement • Only enabling rides to be completed in designated parking areas (potentially through the use of geofencing). • Developing and instigating methods to enable reporting of incorrect parking / abandoned units.	Local transport authorities PMD operators (shared schemes) Support of local enforcement authorities where necessary 

POLICY RECOMMENDATIONS

Reducing the environmental effects of PMD use and operations (lifecycle impacts)

- PMDs have zero emissions at point of use, offering a sustainable alternative to other motorised transport options.
- Increased PMD use (modal shift from personal car journeys) has the potential to:
  - Decrease GHG emissions
  - Improve air quality
  - Increase urban accessibility
  - Reduce congestion
  - Increase multimodal last-mile solutions.
- However, their production (including materials and manufacturing), use and end-of-life/disposal are not emission/resource use-free [Literature].
- There are also emissions associated with the collection and redistribution of shared e-bikes and e-scooters in towns and cities. [Literature].
- Lifespans of shared PMDs, particularly e-scooters, can be considerably shorter than those that are personally owned, contributing to reduced efficiency/increased negative environmental impact per unit.

POLICY RECOMMENDATIONS

Recommendations for addressing lifecycle aspects (environment)

Recommendations	Implementation
Further research is required into understanding the full lifecycle impacts of Micromobility modes.	PMD manufacturers PMD operators
Labelling and product environmental footprinting should be considered within the PMD industry, providing information to consumers, but also driving the industry to improve the footprint of PMDs, increasing their sustainability.	PMD manufacturers PMD operators (shared schemes)

Recommendations for manufacturing and production phase (environment – lifecycle impacts)

Recommendations	Implementation
Consideration should be given to: • Maximising recycled content. • Minimising the carbon intensity of material production. • Future recycling methods for batteries used, including consideration of more universal battery packs/systems, whereby batteries can be swapped/repaired/replaced.	PMD manufacturers

POLICY RECOMMENDATIONS

Recommendations for the PMD use phase (environment – lifecycle impacts)

Recommendations	Implementation
Promotion of maintenance and repair of PMDs where possible rather than replacing them, extending their lifespan.	Local authorities PMD operators
During the servicing/redistribution of PMDs (shared schemes): • Promote the use of energy efficient service vehicles such as EVs or cargo bikes within the PMD redistribution activities. • Digitalise fleet operations to minimise empty runs. • Promote route planning and optimisation across the designated parking zones (linked to addressing correct parking) to ensure number of PMDs serviced in a single trip is maximised and trip distances are minimised. • Promote the use of removable/swappable batteries - so vehicles can remain in location and smaller EVs or cargo/trailer bikes can perform the in-field task.	PMD operators (shared schemes)
Where possible, renewable energy should be used to charge the batteries including dedicated solar PV installed by operating companies.	PMD operators (shared schemes)

POLICY RECOMMENDATIONS

Enabling and promoting modal shift to PMD use (environment)

- As previously mentioned, there are potentially many benefits of increased PMD use as a result of modal shift, including decreases in GHG emissions, improved air quality, increased urban accessibility, reduced congestion, and increased multimodal last-mile solutions.
- However, most can only be achieved where modal shift occurs from private car journeys (and some public transport journeys) or road freight vehicles (in the case of business/deliveries).

Modal shift for business/freight deliveries

- There are increasingly more restrictions in city centres/urban areas for trucks/lorries making freight deliveries (time of day, emissions etc.).
- Although some urban areas remain accessible for truck deliveries, congestion can be an issue, they may incur charges (congestion charges, parking charges), and safety/accidents become a concern [Literature].
- There is potential to move a large proportion of goods in towns and cities by (e-)cargo bike, achieving potential associated emissions reductions [Literature].

Modal shift for personal journeys

- Although PMD use is often viewed as a novelty (‘fun factor’ stated by survey respondents), it does have a place in the sustainable transport system for personal journeys [Literature, Survey].
- Respondents to the survey largely agreed that e-bikes and e-scooters are better for journeys in built-up areas, are more convenient, and lead to benefits such as improved air quality and reduced congestion compared to other transport modes [Survey].
- PMDs offer a ‘last-mile’ solution when coupled with public transport/active travel modes making trips that were previously viewed as being unfeasible, feasible [Literature, Survey].
- They can also offer a replacement for some trips that would otherwise be made by car or other modes [Literature, Survey].

POLICY RECOMMENDATIONS

Recommendations for modal shift (environment)

Recommendations	Implementation
Clearer goals for PMD use should be set (personal / freight journeys) in towns and cities.	Local authorities 
However, it is important that safety and environmental concerns can be fully understood and subsequently addressed to ensure that the potential sustainability benefits of PMD use can be realised [See '*Defining Micromobility and collection of data/statistics*', '*Legislation*' and '*Parking*'].	EU level National authorities 

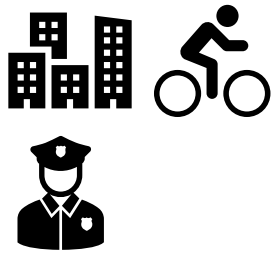
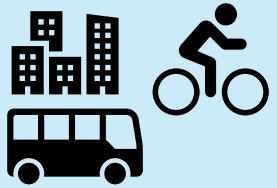
POLICY RECOMMENDATIONS

Recommendations for freight modal shift (environment)

Recommendations	Implementation
Further research is required into safety aspects related to (e-)cargo bike use, including the provision and use of adequate infrastructure/parking. • Supporting infrastructure should be implemented, including freight consolidation centres/hubs, and implementation of cycle lanes and parking where required to facilitate deliveries.	Local authorities 
The potential use of (e-)cargo bikes for freight deliveries should be explored further, including demonstration/pilot projects – making full use of the reliability, low cost, speed and environmental safety benefits associated with their use compared to trucks/vans in urban settings.	Local authorities Businesses 
However, it is important that safety and environmental concerns can be fully understood and subsequently addressed to ensure that the potential sustainability benefits of PMD use can be realised [See '*Defining Micromobility and collection of data/statistics*', '*Legislation*' and '*Parking*'].	

POLICY RECOMMENDATIONS

Recommendations for personal journey modal shift (environment)

Recommendations	Implementation
Further research should be undertaken to fully understand PMD use and modal shift impacts.	Local authorities 
Where modal shift to PMD use is promoted, the potential barriers to using e-bikes and e-scooters need to be addressed in order to enable this shift [see '*Legislation*']. This includes: • Provision of appropriate infrastructure (segregation) • Well-maintained surfaces • Clear rules for use • Better enforcement of the rules • Lower limits on speed • Parking	Local authorities PMD operators (shared schemes) Law enforcement authorities 
Multimodal ticketing with public transport and e-scooter/e-bike rental could be further explored to ensure ease for the user and a reduced risk of complete modal shift away from public transport.	Local authorities PMD operators (shared schemes) Public transport operators 
Where the use of shared e-scooters/e-bikes is promoted, recommendations relating to increasing the lifespan of units should be pursued [See '*Lifecycle impacts*']	PMD operators (shared schemes) 

POLICY RECOMMENDATIONS

Raising awareness and education – rules and safe use of PMDs

- Respondents to the survey reported that they were aware of the rules/regulations for use when they rented or purchased e-bikes and e-scooters, and reported that they were aware of key rules [Survey].
- However, the evidence revealed that the causes of accidents and safety concerns were often related to:
  - Disregard for rules or
  - User inexperience.
- Some of these issues can be overcome through operator or authority-led awareness campaigns and education aimed at raising awareness of the rules and safe use of e-bikes and e-scooters.

Lessons from case study cities

Madrid: General Directorate of Traffic (DGT) awareness campaign (including in Madrid) to raise awareness of proper use of e-scooters to reduce accidents involving pedestrians. Included slogans on buses, and radio/social media campaigns. This coincided with additional surveillance for the campaign period, with fines of 200EUR for serious infractions.

Paris: 'Respect ride' campaign by operator Lime, where riders can sign a charter of goodwill agreeing to good rider behaviour in exchange for a helmet.

POLICY RECOMMENDATIONS

Recommendations for raising awareness and education – rules and safe use of PMDs

Recommendations	Implementation
Awareness campaigns, education and training should be pursued.	Local authorities
This may take a variety of forms: • Larger scale public awareness campaigns – focussing on safety while using or interacting with PMDs, and relevant legislation and rules. • More targeted awareness raising aimed at users of e-bikes/e-scooters whereby information is provided at point of rental (electronically), or stickers/leaflets are attached to units informing the users of key rules. • Literature and promotional material/media highlighting the safe use of e-bikes and e-scooters. • Provision of education and training for inexperienced/new users of e-scooters/e-bikes – focussing on safe use and maintenance.	National authorities Local authorities PMD operators (shared schemes) Law enforcement authorities Relevant NGOs or association
Additionally, increased enforcement of the rules will assist in raising awareness of correct use • [See '*Legislation*'].	Local authorities PMD operators (shared schemes) Law enforcement authorities

REFERENCES – SEE ANNEX FOR DETAILS

1. SAE International (2019) SAE J3194 Taxonomy & Classification of powered micromobility vehicles
2. ITF (2020) Safe Micromobility, The International Transport Forum
3. VOI (2021) Safer streets with shared micromobility Voi's Annual Safety Report June 2021
4. UNECE (2021) Recommendations for Green and Healthy Sustainable Transport – "Building Forward Better", The PEP
5. Fluctuo (2021) European Shared Mobility Index – Annual Review 2021
6. ZAG daily (2021) European update: 360,000 e-scooters available across the continent
7. ZAG Daily (2022a) How many bikes? Mapping the world's bikeshare industry
8. ZAG Daily (2022b) ZAG Data: Over half a million shared e-scooters on Europe's streets
9. Petrillo, Mellino, de Felice and Scudo (2018) Design of a Sustainable Electric Pedal-Assisted Bike: A Life Cycle Assessment Application in Italy, Licensee Intech Open
10. Micro-Mobility for Europe (2021) Micro-Mobility position on EU Battery Regulation
11. Zagorskas and Burinskiené (2019) Challenges Caused by Increased Use of E-Powered Personal Mobility Vehicles in European Cities.
12. Eurocities (2021) Playing by the rules: Report on e-scooter operators and fleets in cities - a survey of city approaches and options to optimise regulations
13. Stigson et al (2021) Electric scooters accidents: Analyses of two Swedish accident data sets, Accident Analysis and Prevention 163 (2001) 106466
14. FERSI (2020) E-scooters in Europe: legal status, usage and safety Results of a survey in FERSI countries
15. CARRS (2020) e-Scooter Safety
16. Boglietti et al, (2021) Survey on e-Powered Micro Personal Mobility Vehicles: Exploring Current Issues towards Future Developments
17. CARRS (2021) E-scooters in Brisbane
18. Störmann (2020) Characteristics and Injury Patterns in Electric-Scooter Related Accidents - A Prospective Two-Centre Report from Germany, Journal of Clinical Medicine, MDPI
19. Bloomberg et al (2019) Injury from electric scooters in Copenhagen: a retrospective cohort study, BMJ Open access
20. Gössling (2020) Integrating e-scooters in urban transportation: Problems, policies, and the prospect of system change.

REFERENCES – SEE ANNEX FOR DETAILS

21. Tuncer et al (2020) Notes on the practices and appearances of e-scooter users in public space, Journal of Transport Geography
22. Schepers et al (2018) The Safety of E-Bikes in The Netherlands: Discussion Paper, OECD/ITF
23. RACV (2015) Safety implications of e-bikes
24. Narayanan, S and Antoniou, C (2022) Electric Cargo Cycles - A Comprehensive Review
25. Baloise (2020) Baloise crash test highlights consequences for accidents involving electric scooters and bikes
26. Holve et al (2021) Safe use of Micromobility Devices in Urban Areas, European Platform on Sustainable Urban Mobility Plans
27. Møller et al, (2020) Micromobility: Moving cities into a sustainable future, EY
28. TIER Mobility (2020) Written evidence submitted by TIER Mobility (ESC0067)
29. Schweitzer & Mikolajczak (2022) Disposal e-bikes? The problem with unrepairable batteries
30. Cazzola and Crist (2020) Good to Go? Assessing the Environmental Performance of New Mobility
31. Markvica et al, (2020) E-Scooter as Environmentally Friendly Last Mile Option? Insights on Spatial and Infrastructural Implications for Urban Areas based on the Example of Vienna
32. Guy et al, (2021) Study on market development and related road safety risks for L-category vehicles and new personal mobility devices, EC report by TRL
33. Lime (2019) Lime for a sustainable Paris
34. TIER (2021) How green are electric scooters? New insights on the environmental impact of shared e-scooters
35. Moreau et al, (2020) Dockless E-Scooter A green Solution for Mobility? Comparative Case Study between Dockless E-Scooters, Displaced Transport, and Personal E-Scooters
36. Voi Technology (2019) Sustainability Statement
37. Dott (2022) More than just carbon neutral
38. Hollingsworth et al, (2019) Are e-scooters polluters? The environmental impacts of shared dockless electric scooters, Environmental Research Letters 14 (2019) 084031
39. Bortoli & Christoforou (2020) Consequential LCA for territorial and multimodal transportation policies: method and application to the free-floating e-scooter disruption in Paris
40. WHO (2022) Walking and cycling: Latest evidence to support policy-making and practice

REFERENCES – SEE ANNEX FOR DETAILS

21. Baloise (2020) Baloise crash test highlights consequences of accidents involving electric scooters and bikes
22. ECF (2012) Cargo Bike Crazy: The potential of delivering goods by bike
23. Cyclelogistics (2022) European Cargo Bike Survey Results 2022
24. Hayes (2022) How long do electric scooters last?
25. ADAC (2022) So nutzen die Deutschen E-Scooter