1.0 Introduction to Neuron

Neuron is an experienced e-scooter operator with a footprint across Australia and New Zealand, currently operating in Brisbane, and is looking to launch in Darwin and Auckland, New Zealand in the coming months.

Neuron operates with four key tenets as part of our company's DNA - Safety, Accessibility, Innovation and Sustainability. These operating principles permeate throughout the company - from the design and manufacture of our hardware and software to our on-the-ground operations.

Neuron prides itself as an innovative product centric company. Distinctive innovation capabilities and assets include Neuron's proprietary generation 3 scooter (N3), built with mass-sharing in mind. N3 has a lifespan of up to 1-2 years (effectively 5-10x the lifespan of commercially available scooters when used for mass sharing) and therefore reduces Neuron's supply chain **carbon emissions to 10-20% of its competitors**. Neuron is the **pioneer in battery swappable electric scooters** which enables low-battery scooters to be put back into service within 2 minutes instead of requiring the whole fleet of electric scooters to be hauled back and charged for 6-8 hours. Hence, **Neuron does not require an army of hydrocarbon-based vehicle** to run its operations and emits significantly less carbon emission compared to other operators.

Neuron implements the concept of **preferred parking by deploying geofence and near-field technology (NFC)** to incentivize users to park at appropriate locations so as to reduce clutter on the street while maintaining convenience for users. **Users are further incentivized to wear a helmet** through Neuron's proprietary "helmet selfie" incentivization program. Neuron also deploys **geofencing technology to provide unprecedented control over user behaviour** (speed, parking, and area of operations).

Neuron commits to **providing free helmets** with its scooters. Neuron would also deploy an "**industry-first" physical helmet attachment mechanism** to ensure that helmets are affixed mechanically to scooters. In addition, Neuron has also deployed a new **fall-detection feature** which would automatically detect a fall on Neuron's scooter and provide assistance to users as necessary.

Neuron's operators are fully in-house thus giving Neuron greater control over operator performance, safety and compliance.

Neuron is the **only operator in the Asia Pacific region to have successfully integrated with a Mobility-as-a-Service Platform (MaaS)**, MobilityX in Singapore. Beyond that, Neuron is in the process of launching several MaaS pilots with Queensland's Department of Transport and Main Roads. Neuron is capable and willing to integrate with any MaaS platform that might be operating in the area to bring better transport options to cities.

Neuron is excited to work with the NTC on defining the regulations to enable safe yet accessible use of PMDs across Australia.

2.0 Response to "What to submit"

2.1 Is the definition of the problem accurate?

Yes, Neuron believes that the definition of the problem is accurate. It is also important to note the wider benefits of PMDs where they're able to boost economic activities by enabling movements and support emerging industries such as food-delivery and small parcel delivery.

2.2 What are the likely costs and operational impacts of the problem for government bodies, businesses/operators and other organisations?

2.2.1 Cost to government

Neuron sees the likely costs of the problem to government would be the communication of the regulatory standard across the nation, as well as the consistent national policing and enforcement of regulations. Without a consistent framework to apply across the nation, state governments that are keen to have a framework in place may take the initiative themselves and decide on regulations for their own states. This can lead to confusing and inconsistent regulations across the nation, especially if certain jurisdictions may not have taken into consideration all relevant criteria.

As the Consultation RIS rightfully points out, in states where regulations around PMD usage has not been set up, there are already many users using PMDs, unaware that these devices are currently illegal or operating in a grey zone[1]. The growth of PMDs as a transport mode will only continue to grow; without the NTC taking the lead to set up nationwide regulations, PMD users in these states will continue to use their devices in an unregulated manner, which is very dangerous both for users and other road / path users.

Neuron believes that the NTC has the opportunity to set the tone and forge a new approach to governing the future mobility ecosystem. As urbanisation continues to grow, and with citizens always on the move seeking new, innovative and environmentally sustainable ways to move around their city, different and new modes of travel and micro-mobility will continue to pop up and evolve[2]. By taking the lead and setting new regulations for PMDs, the NTC is leading the way in showing its willingness to be adaptive and proactive in updating regulations as mobility options evolve.

2.2.2 Cost to operators

Neuron defines operators as operators of e-scooter share scheme companies as well as PMD importers and manufacturers. All other businesses outside of these two types are discussed in 2.2.3.

Without clarity, operators find it difficult to understand which and how regulations may apply to them, especially if regulations differ across states. For instance, a standard definition of what allowed or legal PMDs will provide clarity on the types of vehicles and devices that can be imported or manufactured.

[1] https://www.racv.com.au/royalauto/moving/news-information/victorians-embrace-illegal-escooters.html

[2] https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/micro-mobility-is-the-future-of-urban-transportation.html

Differing regulations across states also increases the cost of doing business - operators lose economies of scale if regulations differ across states and devices.

Operators will also find it difficult to know how and where to invest resources and money to build their businesses and create jobs without standardised regulation. If they are operating in a grey zone, operators will be reluctant to invest into long term capabilities and soft infrastructure that can create significant economic benefits outside of the direct business. For instance, a lack of clarity makes it difficult for operators to negotiate long term contracts with their suppliers of parts or PMDs. Similarly, it is difficult to attract and retain employees for operators in this sector, reducing knowledge and know-how transfer opportunities as well as new job opportunities.

2.2.3 Cost to businesses

For businesses, the lack of clarity also makes it difficult to invest in the industry and ecosystem around e-scooters. For instance, Neuron has worked with partners such as tour providers and small local businesses such as cafes (https://www.neuron.sg/7-coffee-spots-to-visit-in-brisbane/) to highlight them to our users and bring customers to their door, especially in areas with less footfall.

Without clarity on the usage of PMDs, businesses will be reluctant to work and partner with operators that can help to enhance the visibility of and grow their business. Businesses may also be reluctant to market to PMD users. For instance, in the United States, e-scooter share companies are partnering with real estate landlords to enhance micro-mobility transportation options for tenants of these buildings, giving these landlords an edge over the competition while also solving related issues that crop up from these e-scooter share schemes[3]. Such growth opportunities and revenues will be lost without clarity in regulation.

Another lost opportunity would be the ability of PMDs to increase revenues for businesses in budding industries such as F&B or goods delivery. Deliveries done on PMDs allow them to reach customers that might otherwise be out of reach or too expensive to service. Several food delivery markets across the globe have shown this to not just be viable, but a way to stand out from the competition[4]. This also creates new employment opportunities for the wider community. Another example where PMDs have enabled an emerging industry is the use of PMDs in last mile small parcel deliveries.

At scale, well operated micro-mobility solutions are able to reduce the number of vehicles on the road. This reduction in reliance on road would enable faster commuting, better connectivity and shorter delivery times for businesses. This would lead to a boost in economic activities.

[3] https://fortune.com/2019/12/12/scooter-startups-real-estate-micromobility/

[4] https://www.cnbc.com/2019/08/13/dominos-embraces-delivery-via-e-bike-following-in-the-footsteps-of-grubhub-and-ubereats.html

2.3 What are the likely costs and operational impacts of the problem on the broader community?

2.3.1 Impact to broader community

Without a clear regulatory framework, the wider community is unable to identify if and when a PMD is being operated or used in a legal and appropriate way. This can be costly to access and amenity for pedestrian users, as has been pointed out in the Consultation RIS. The implementation of standard regulations will give shared path users peace of mind that authorities have taken this issue seriously and have taken the necessary steps to assess safety risks and put together a regulatory framework.

As alluded to the Consultation RIS, a related issue with the lack of regulatory clarity has led to a difficulty in collecting data around the real benefits and also risks of PMD usage. Without standardised regulatory standards, members of the community that may have observed dangerous usage of PMDs and road infrastructure will not be aware of whether such usage is legal or not, and may not report such incidents. There is also no single regulatory authority to follow up on such reports. This again, will have indirect access and amenity impacts for other pedestrian and pathway users.

Ongoing regulatory uncertainties can also lead to friction between the wider community and PMD users[5]
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2.3.2 Impact to PMD users

Research has been done in the United States that shows how inconsistent regulations can lead to a lack of clarity for PMD users on what rules to follow[6]. The RACV has also done a survey which shows that users would still use PMDs even if they were deemed illegal[7]. A standard regulatory framework will help enforce safe use of these PMDs and enable the policing and compliance of dangerous and illegal use of PMDs.

2.4 Is government action needed?

Yes, government action is needed to:

1. Provide regulatory clarity and synchronization to tackle confusion on usage of PMD devices in the public
2. Set a standard of safety for sharing and private PMDs. As stated in Section 2.5, if the market remains unregulated, private PMDs would continue to proliferate. Without a minimum safety standard, regulatory clarity and enforcement, private PMDs are likely to be modified to boost performance at the cost of safety

[5] https://www.washingtonpost.com/business/economy/pedestrians-and-e-scooters-are-clashing-in-the-struggle-for-sidewalk-space/2019/01/11/4ccc60b0-0ebe-11e9-831f-3aa2c2be4cbd_story.html

[6] https://transweb.sjsu.edu/sites/default/files/1713-Fang-Agrawal-Hooper-Rules-Personal-Transportation-Devices_0.pdf

[7] https://www.racv.com.au/royalauto/moving/news-information/victorians-embrace-illegal-escooters.html

Compliance from both operators, its users and private owners of PMDs require clarity in regulations.

2.5 Are there other related issues you consider relevant?

Although this regulatory review pertains to the use of PMDs at different speeds on different infrastructure as per the Australian Road Rules, Neuron believes that there are also benefits to regulating the PMDs themselves. As discussed in Section 3.1, not all PMDs are built with equal risk; some have inherently higher risks than the others.

There have been numerous reports of private PMDs bursting into flames while being charged primarily due to unapproved modification on PMDs and use of unapproved batteries & chargers. This can be dangerous especially in high-rise residential areas[8]. Globally, regulators have taken note of this risk, and have put in regulations to restrict PMDs to only UL certified devices[9]. Device safety and UL compliance should also be taken into consideration.

3.0 Responses to Questions asked in RIS

3.1: Are the requirements in the proposed regulatory framework appropriate? Are there any requirements that should be removed, included or modified? Please provide a rationale to support your position.

Neuron believes that the definition for e-scooters in Table 2 (Proposed Regulatory Framework for PMDs) is apt. However, it is worth noting the definition covers any electric vehicle which meets the requirements with 1 wheel or more. The risk of each PMD device differs significantly based on several factors:

- Number of wheels:
  - One-wheeled PMD is a 2-axis instability (front-back, left-right) system
  - Two-wheeled PMD is a 1-axis instability (left-right) system
  - Four-wheeled PMD is a 0-axis instability system
- User positioning method:
  - Seated PMDs lower the center of gravity of users and therefore allows better control
  - Standing PMDs have higher center of gravity
- Existence of a forward position fixed structure (handlebar and stem):
  - Without a front handle bar, a user on a PMD has a 2-axis instability (front-back, left-right)
  - With a front handle bar, a user is able to hold on to the handlebar to create a 0-axis instability system
- Brakes
  - Electrical brakes only: E-brakes do not respond to pressure applied by users and may be less effective at sudden braking than mechanical drum brakes

[8] https://www.todayonline.com/singapore/fires-involving-e-bikes-e-scooters-51-cent-2018-scdf

[9] https://www.lta.gov.sg/content/dam/ltaweb/corp/GreenTransport/2018/UL2272/ul2272_certified_pmds.pdf

  - Mechanical drum brakes only: Mechanical brakes respond directly to pressure applied by a user and is typically more effective for braking over a short distance
  - Electrical brakes + Mechanical drum brakes: More effective form of braking on a PMD. When both brakes are in use, stopping is possible over a shorter distance. If one of the two brakes fail, the other acts as a fail safe
  - Back-wheel foot brakes: A primitive form of mechanical brake. Requires users to shift their center of gravity in the event of braking which may pose increased risk of falling
- Weight distribution
  - Top-heavy PMDs have a higher center of gravity and therefore is more prone to instability
  - Bottom-heavy PMDs have lower center of gravity and therefore is more stable
- UL compliance
  - Devices not compliant with UL standards increases the risks of fire while charging

3.2: Is 60kg a suitable maximum weight for a PMD? If not, what is a more suitable weight and what other factors should be considered? Please provide a rationale to support your position.

In general, Neuron's scooter weights between 20-22kg. That being said, Neuron believes that a higher weight restriction is complementary to the safety innovation efforts by manufacturers and operators. Example of safety innovations that adds weight to the scooter:

- Larger wheels (Neuron has a 12" wheel which allow users to negotiate road imperfections safer)
- Helmet lock (Neuron's scooters would include a helmet lock device to ensure that helmets are attached to its scooters physically)

That being said, Neuron understands that the speed approach recommended in the paper is based on comparative analysis of kinetic energy of impact with MMDs. For this purpose, Neuron believes that utilization of 60kg for the weight limit in Table 6 is too high as most scooters are currently below 30kg. For further discussion, please refer to Section 3.7.

3.3: Should children under the age of 16 years old continue to be permitted to use a motorised scooter incapable of travelling more than 10km/h on level ground on roads and paths? Or should they be able to use any device that complies with the proposed PMD framework? (see Appendix A). Please provide a rationale to support your position.

No, Neuron believes that children under the age of 16 should not be allowed to ride a motorised scooter regardless of the speed limit. There are a few reasons for this:

- Difficulty in communicating differentiated rules for the operation of PMDs for children vs. adults. For other forms of personal transportation, the rules are either similar for children and adults (bicycle rules), or there is a clear-cut age delineation (driving and motorbike use)
- Costly and difficult to enforce compliance and policing especially in the speed limit and checking the age of the rider

- According to the Centers for Disease Control and Prevention[10], the average height of a 10-year old boy and girls is fairly similar at 140 cm. This height profile should be fairly similar for New Zealand. At this height, it is difficult for children to look over and operate e-scooters that have a handlebar and stem - for instance, the Neuron e-scooter is 122.5 cm tall and the Ninebot MAX is at 120 cm. These may lead to instances where children may find it difficult to retain control of the scooter.

3.4: Do you agree with the criteria selected to assess the options? Are there any key impacts not covered by these criteria?

Neuron agrees that most of the key criteria have been covered in assessing the options. Neuron would suggest also considering some other impacts as mentioned below.

Environmental benefits should also be included in the criteria selected to assess the options. By taking these benefits into consideration, considerations such as how a given option may help to encourage car replacement, connect to existing public transit modes or impact main commuting routes would influence how an option may be picked.

Another key impact that should be considered are infrastructure impacts. Given the real feasibility of PMDs as a commuting option, how the new regulatory framework is put in place could have knock-on effects on local infrastructure such as roads and paths. For instance, considerations such as whether a particular regulatory framework could impact infrastructure constraints such as traffic jams, or could impact wear and tear on existing infrastructure should be taken into consideration.

3.5: When considering the safety risk assessment, access and amenity impacts, broader economic impacts, as well as compliance and enforcement impacts; has the impact analysis sufficiently considered all relevant variables and available evidence? What other factors could be included in the analysis? Please provide any additional evidence.

Neuron agrees that the impact analysis has covered the most important aspects of PMD regulation. Within these impacts, the most important relevant variables have also been considered. To a smaller extent, the NTC can consider the safety impacts not just from falls from PMDs in usage or direct collisions with other path users, but also with surrounding infrastructure. Neuron believes that this is covered by setting limitations on where PMDs can travel as well as an appropriate speed approach. This is further discussed in 3.7.

Outside of these four impacts, other impacts that should be considered are covered in 3.4.

[10] https://www.cdc.gov/growthcharts/data/set1clinical/cj41c021.pdf; https://www.cdc.gov/growthcharts/data/set1clinical/cj41c022.pdf

3.6: What do you believe is the most appropriate road infrastructure for PMDs to access: footpaths, separated paths, bicycle paths and/or roads? Please provide a rationale to support your position.

Neuron believes that the most appropriate road infrastructure for PMDs are footpaths, separated paths, bicycle paths and local roads with speed limits <50km/h. Neuron believes that these forms of road infrastructure, balanced by different speed limits depending on the infrastructure (refer to 3.7.4 for more information), gives the most optimal balance between safety as well as access and amenity for both PMD users as well as other users of these forms of road infrastructure.

In terms of access and amenity, PMDs are used to cover short to medium distances, and are intended to be a supplement to longer distance travelling that can be covered using public transport systems. Neuron has seen this to be true in actual operations - on average, Neuron's trips are roughly 2km, covering roughly the distance of a short walk (up to a maximum of 20 minutes).

Currently, most public transport journeys start and end with a walk from the public transit stop to the final destination, with bicycles becoming increasingly popular as well[11]. All state and territory governments, including many local governments have policies in place to encourage walking, riding and use of public transport. Allowing the use of PMDs on forms of infrastructure that currently supports walking and riding will go a long way to supporting this move towards shift public transport instead of driving.

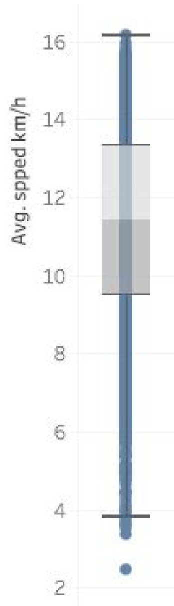
This, of course, is counterbalanced against safety concerns for PMD and other path users and is further discussed in 3.7.4.

3.7: What is an appropriate and safe maximum speed that PMDs should be permitted to travel across the various infrastructure: (a) pedestrian areas, (b) bicycle areas, and (c) roads? Please provide a rationale to support your position.

3.7.1 Self-regulation of speed vs maximum speed limit

Plot below represents a specific area of Neuron's operations in Brisbane with a 15 km/h speed limit between 29/11/2019 to 09/12/2019 with a total sample size of 2,600 users and 3,700 trips. Dataset below does not include data points when speed of scooter is 0 km/h.

11 https://www.infrastructure.gov.au/infrastructure/pab/active_transport/files/infra1874_mcu_active_travel_report_final.pdf



The data set ranges from 2 km/h to 16 km/h (mainly due to riding on downward slopes which is expected to be solved with Neuron's new downward slope speed control feature).

On median, users' average speed falls between 9.5 km/h to 13.5 km/h in a 15 km/h maximum speed zone. On average, users' average speed is 11.5 km/h or ~75% of maximum speed. This trend point towards the evidence of speed self-regulation by users.

Similar trend is observed in areas with 25 km/h maximum speed limit as well.

3.7.2 Not all infrastructure is built equal

Not all infrastructure is built equal. Width of pedestrian areas vary significantly across cities and even within any city itself. In addition, foot traffic needs to be taken into consideration to determine the appropriate speed limit for a specific area. For example, 25 km/h may be risky on a narrow CBD street with high foot traffic but it is a comfortable cruising speed for connecting areas between suburbs.

3.7.3 Speed enforcement by operators

For most operators, including Neuron, enforcement of these speed limits are very effective through the use of geofences. No Neuron users would be allowed to go beyond the maximum speed limit in a specific area, even if they're on a downslope (with Neuron's downslope speed control feature). As such, it does not create additional enforcement challenges for local authorities if enforcement is done at the operator level rather than at the single individual user level.

3.7.4 Maximum speed for different areas

Pedestrian areas

Neuron believes that the maximum speed for pedestrian areas should be set to 15 km/h as the calculations below shows the option has a comparable kinetic energy to the baseline case (MMDs at 10 km/h) and will significantly increase utility of PMDs.

To quote the paper "Permitting PMDs to travel up to a maximum of 10km/h on pedestrian infrastructure is an appropriate speed based on safety considerations for pedestrians". This recommendation is based on the premise in Table 6 (also shown below). Neuron understands that 10 km/h is chosen for pedestrian area because it presents a comparable risk with MMD with a max weight of 110 kg and speed limit of 10 km /h thus producing a kinetic energy of 424 KJ. However, there seems to be an error in table 6. Table 6A shows the corrected kinetic energy calculation.

Using that same train of thought, Neuron believes that 15 km /h is the appropriate maximum speed for pedestrian area for several reasons:

1. A corrected version of the table is presented in Table 6A. At 60 kg maximum device weight and 15 km/h, the kinetic energy of PMD (row 3) is at 1215J compared to the corrected kinetic energy of MMD (row 1) at 733 J. This shows that the kinetic energy of PMD (row 3) at 15 km/h is more comparable to kinetic energy of MMD (row 1) than previously presented.

2. As discussed in section 3.2, Neuron believes that a higher weight limit enables innovation in safety technology. However, 60 kg is significantly above any common PMD device currently. Neuron's N3 weighs 23 kg, Lime's Gen 3 weighs 24 kg and Ninebot's commercially available ES Max scooters weighs 19 kg. While Neuron expect its vehicle to increase in weight over time, it does not at this time foresee a ~3x increase in vehicle weight. For the purpose of KE calculation, perhaps utilizing 40 kg (ample room for innovation and growth in technology compared to current weight) reflects a more realistic picture on the potential risks with PMDs compared to MMDs. Please refer to Table 6B for adjusted energy differentials. Table 6B shows that row 3 (PMD, 15 km/h) has a comparable KE of 1042 J compared to the row 1's (MMD, 10 km/h) KE of 733 J.

3. An increase of speed from 10 km/h to 15 km/h would significantly increase the utility of PMDs. As discussed in Section 3.7.1, on average, the average speed of users are at ~75% of maximum speed limit set. With a 10 km/h speed limit, average speed of users would be 7.5 km/h which is equivalent to a slow jog thus significantly decreasing the utility of PMDs as users are not likely to use a service that does not significantly improve their travel experience over walking or slow jog. If the speed limit is set at 11.5 km/h, the average speed of users would be 10.5 km/h which almost matches a running speed thus unlocking PMDs as a true alternative mode of transport.

Table 6. Kinetic energy differentials for PMDs and motorised mobility devices

	Person (kg)	Device (max. kg)	Speed (max km/h)	KE (J)
MMD	80	110	10	424
PMD	80	60	10	386
PMD	80	60	15	1215
PMD	80	60	25	3375

Table 6A. Corrected energy differentials for PMDs and motorised mobility devices

	Person (kg)	Device (max.	Speed (max	KE (J)
MMD	80	110	10	733
PMD	80	60	10	540
PMD	80	60	15	1215
PMD	80	60	25	3376

Table 6B. Adjusted energy differentials for PMDs and motorised mobility devices

	Person (kg)	Device (max.	Speed (max	KE (J)
MMD	80	110	10	733
PMD	80	40	10	463
PMD	80	40	15	1042
PMD	80	40	25	2894

In addition, Neuron would propose for local city councils to have the ability to assign higher speed areas (potentially 20 km/h) to cover areas between suburbs, where infrastructure is suitable, distance is longer and risk to pedestrian and rider is minimal.

Bicycle areas

Neuron agrees with NTC's assessment "a maximum permitted speed of 25km/h is considered safe and suitable for bicycle paths and is likely to align more with the existing speed that bicycle riders travel (i.e. between 20km/h and 30km/h)" where differential speed between bicycles and PMDs is minimized, reducing the risk of dangerous overtaking.

Roads

Neuron agrees with NTC's recommendation of setting maximum speed limit of PMDs at 25 km/h on local roads.

3.8: Do you agree with the overall assessment that Option 3, Speed Approach 1 is the option that best balances mobility and safety? If not, which option and speed approach do you prefer? Please provide a rationale to support your position.

Neuron agrees with Option 3 to enable maximum utility of the new transport mode and minimize risks and severity of PMD/vehicle collision.

Neuron proposes the consideration of an adjusted Speed Approach 1 where maximum speed limit of PMDs on footpaths and shared paths is increased from 10 km/h to 15 km/h while maximum speed limit of PMDs on bicycle paths and local roads are maintained at 25 km/h. Please refer to Section 3.7.4 for Neuron's argument on increasing maximum speed limit of PMDs on footpaths and shared paths.