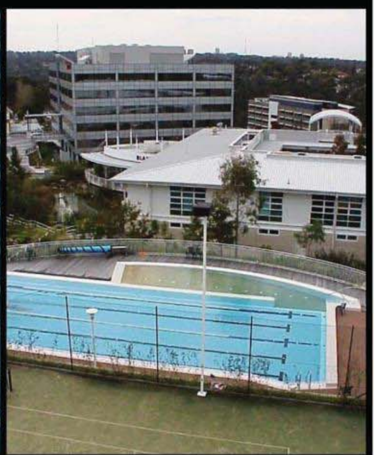
ITEM 6 (continued) **ATTACHMENT 4**

Macquarie Park Planning Incentive Scheme Risk Management Plan

PREPARED FOR

Ryde City Council

September, 2013



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ITEM 6 (continued) **ATTACHMENT 4**

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ITEM 6 (continued) **ATTACHMENT 4**

CONTENTS

ITEM 6 (continued) **ATTACHMENT 4**

EXECUTIVE SUMMARY

The Ryde Local Environmental Plan 2013 Draft (Amendment 1) Planning Incentives Scheme ('the Scheme') seeks to deliver increased density in the Macquarie Park Corridor and associated infrastructure in line with Sydney's Metropolitan Strategy Plan. The delivery of new roads and parkland will support employment growth and the evolution of the Macquarie Park Corridor from Business Park to specialised employment centre with a key focus on research and technology

The purpose of the brief is to prepare a Risk Management Plan in accordance with International Standard for Risk Management (ISO 31000:2009) for the risks associated with the Scheme. This Risk Management Plan has been prepared in consultation with a range of stakeholders including members of the Project Team and representatives from City of Ryde Council.

The key risks associated with the Scheme are identified and measures are suggested. The risks are grouped under five categories:

- **Planning Risk**
  The risk that the planning process fails to deliver the expected desired outcomes
- **Timing Risk**
  The risk that the crucial elements do not occur in alignment
- **Financial Risk**
  The risk of a funding shortfall to provide and maintain the infrastructure
- **Market Risk**
  The risk that market conditions do not incentivise redevelopment
- **Delivery Risk**
  The risk that a counterparty in a transaction may not be able to fulfil its side of the agreement

The Risk Management Plan makes the following overarching recommendations to Council to help minimise the impact of risk occurrence.

- The development of an infrastructure staging plan to provide greater certainty;
- Council actively negotiating the delivery of a catalyst project to "kick start" the scheme;
- Council resourcing to facilitate successful delivery of the project;
- Increased levels of stakeholder and landowner engagement; and
- Site specific guidelines to provide greater certainty for developers.

The City of Ryde Council will assume ownership of the Risk Management Plan and be responsible for periodically reviewing the implementation of mitigation measures and monitoring the project risk over the life of the project.

1. Introduction

1.1 Background and Overview

The City of Ryde has recently exhibited the Macquarie Park Corridor Planning Proposal which outlines proposed changes to the Local Environmental Plan (LEP) 2013 and the justification for making those changes. One of the key changes proposed is the introduction of a Planning Incentives Scheme ('the Scheme') which seeks to amend the floor space ratios (FSR) and building heights within Macquarie Park in order to encourage development and facilitate the associated delivery of new roads and parklands.

The proposed changes to the LEP include new maps and deferred provisions for increased FSR and building heights for those developments which enter into a Voluntary Planning Agreement (VPA) to deliver new roads and/or parks either in kind or via a monetary contribution.

1.2 Purpose and Scope of Brief

The purpose of the brief is to prepare a Risk Management Plan for the Scheme in accordance with International Standard for Risk Management (ISO 31000:2009).

The scope of the brief is to review the Planning Incentives Scheme, identify the inherent risks within the scheme and to identify analysis and treatment options for those risks. The risks will be identified in a Risk Management Plan which may contribute to changes in the planning controls prior to the Council finalising the Planning Incentives Scheme and the associated planning controls.

1.3 Approach and Methodology

To fulfil the requirements of the project brief the following documents were reviewed:

- The Ryde Local Environmental Plan 2013 Draft (Amendment 1);
- The Ryde Local Environmental Plan 2010;
- The Macquarie Park Plan Review Issues and Options Paper;
- The Macquarie Park Infrastructure and Planning Framework Analysis;
- Submissions received on Ryde Local Environmental Plan 2013 Draft (Amendment 1);
- The International Standard for Risk Management (ISO 31000:2009); and
- NSW Treasury Guidelines for Capital Business Cases.

Hill PDA also participated in a Risk Identification Workshop with the City of Ryde Council in which key risks were identified and discussed.

ITEM 6 (continued) **ATTACHMENT 4**

2. Risk Management Framework

2.1 Introduction

The Risk Management Framework has been prepared to manage the project's risks with a focus on whole of life outcomes in accordance with AS/NZISO31000:2009 *"Risk Management – Principles and Guidelines"*. The Framework defines project risk as the chance of an event occurring that may positively or negatively, directly or indirectly affect the planned project outcomes and / or total project cost. The Framework identifies:

- The method by which project risk will be identified;
- The method by which project risk will be assessed through an assessment of the likelihood of occurrence and risk consequence both without and with regard to proposed mitigation strategies;
- How risk controls or mitigation strategies should be developed;
- Project risk response priorities, including the level of unacceptable project risk; and
- How project risk should be monitored and reported throughout the life of the project.

The Risk Management Framework has been given effect by the development of a Risk Management Plan for the project. The Risk Management Plan was proposed in consultation with a range of stakeholders including members of the Project Team and representatives from City of Ryde Council.

The Risk Management Plan provides a basis for:

- Identifying, assessing and managing project risks by risk source, project phase and affected project objective.
- Allocating project risk.
- Assigning accountability for ownership and management of project risks throughout implementation of the project.
- Establishing a systematic process for monitoring the occurrence and effective amelioration of project risk over the life of the project.

The Risk Management Plan can be integrated into all project phases and should be carried out throughout project delivery. The City of Ryde Council will assume ownership of the Risk Management Plan and will be responsible for periodically reviewing the implementation of mitigation measures and monitoring the project risk.

Given that the project operates in a dynamic market place, management of the Plan will require regular review (6 to 12 months).

2.2 Guidelines and Principles

The International Standard for Risk Management (ISO 31000:2009) outlines principles and generic guidelines for the design, implementation and maintenance of risk management processes throughout an organisation. This standard can be applied to any type of risk, whatever its nature, whether having positive or negative consequences.

The International Standard identifies a series of steps to undertake in a logical order when dealing with risk:

- Avoid the risk by deciding not to start or continue with the activity that gives rise to the risk;
- Accept or increase the risk in order to pursue an opportunity;
- Remove the risk source;
- Change the likelihood;
- Change the consequences;
- Share the risk with another party or parties (including contracts and risk financing); and
- Retain the risk by informed decision.

2.3 Implementation

The success of risk management will depend on the effectiveness of the management framework providing the foundations and arrangements that will be embed it in the organisation at all levels. The framework ensures that information about risk derived from the risk management process is adequately reported and used as a basis for decision making and accountability at all organisational levels.

The on-going effectiveness of risk management requires strong and rigorous planning to achieve commitment at all levels. Council should:

- Define and endorse the risk management policy.
- Ensure the organisation's culture and risk management policy are aligned.
- Align risk management objectives with the objectives and strategies of the organisation.
- Ensure legal and regulatory compliance.
- Assign accountabilities and responsibilities at appropriate levels within the organisation.
- Ensure the necessary resources are allocated to risk management.
- Communicate the benefits of risk management to all stakeholders.
- Ensure that the framework for managing risk continues to remain appropriate by way of regular review and monitoring.

ITEM 6 (continued) **ATTACHMENT 4**

3. Macquarie Park Planning Incentive Scheme

The Ryde Local Environmental Plan 2013 Draft (Amendment 1) introduces a Planning Incentive Scheme within the Macquarie Park corridor. The purpose of the Ryde Local Environmental Plan 2013 Draft (Amendment 1) is to deliver increased density for the Macquarie Park Corridor and associated infrastructure in line with Sydney's Metropolitan Strategy Plan. The delivery of new roads and parkland will support employment growth and the evolution of the Macquarie Park Corridor from Business Park to specialised employment centre with a key focus on research and technology.

The objectives of the Ryde Local Environmental Plan 2013 Draft (Amendment 1) are to:

- Reinforce the importance of Macquarie Park Corridor as an employment centre;
- Cater for growth and respond to the need for the Corridor to develop and change in a manner that allows the area to remain competitive;
- Enable the delivery of new road and park infrastructure to support the growth of the area.

The Planning Incentive Scheme has been prepared in accordance with Section 55 of the *Environmental Planning and Assessment Act 1979*. It seeks to build on the previous Ryde Local Environmental Plan 2010 which identified planning incentives for the provision of new roads. The Ryde Local Environmental Plan 2013 Draft (Amendment 1) refines the LEP 2010 to comply with the NSW standard Instrument and to ensure clarity and development certainty.[1] Based on current timelines, it is anticipated the Planning Incentive Scheme be adopted in April-May 2014.

The scheme seeks to defer the availability of additional Floor Space Ratio (FSR) and height until the developer negotiates with Council to carry out works-in-kind, e.g. deliver roads and/or parks, or provide a monetary contribution in lieu (specified at $250/sqm of additional floor space). The increased FSR ratio and building heights which form part of the Scheme are included on maps which form part of the proposed LEP Amendment.

In the case of developers electing to provide works-in-kind instead of making a monetary payment, land dedications would be credited at a rate of $250/sqm of site area. This credit offset is predicated on the basis that the development potential of the land dedicated can be 'harvested' and transferred to the remainder of the site.

Once a Voluntary Planning Agreement is executed, the increased building height and FSR is made available through a minor site specific LEP amendment. The Planning Incentive Scheme is entirely voluntary and if a developer chooses not to enter into the agreement, the existing Ryde LEP 2013 will apply.

The Planning Incentive Scheme has been designed to leverage off increased density and height provisions and harness private sector investment. It is intended that a review of the scheme be undertaken after ten years and the contribution rate of $250/sqm be reviewed on an annual basis as part of the Council's end of financial year fees and charges review.

[1] City of Ryde, Urban Planning Unit, Planning Proposal for Macquarie Park Corridor

4. Risk Identification and Mitigation

Risk assessments identify a range of risks and the likelihood of such risks eventuating. More significantly, they identify mitigation measures which can either remove or decrease the level of risk.

The key risks associated with the Planning Incentives Scheme can be grouped into five categories:

1. ***Planning risk***
   The risk that the planning process fails to deliver the expected desired outcomes
2. ***Timing risk***
   The risk that the crucial elements do not occur in alignment
3. ***Financial risk***
   The risk of a funding shortfall to provide and maintain the infrastructure
4. ***Market risk***
   The risk that market conditions do not incentivise redevelopment
5. ***Delivery risk***
   The risk that a counterparty in a transaction may not be able to fulfil its side of the agreement by failing to deliver the underlying asset or the cash value of the contract

These are summarised below and include proposed mitigation strategies:

4.1 Planning Risk

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Moderate)***
1. Execution of Voluntary Planning Agreements	
▪ Development does not proceed due to delay and cost involved with negotiating and finalising VPA.	▪ Commence VPA discussions early by way of the formal pre-lodgement process for major developments. Generally, VPAs are agreed between the developer and Council prior to DA being reported to planning authority. ▪ Where appropriate, Council engages QS to advise/verify VPA offers in relation to their community benefit.

ITEM 6 (continued) **ATTACHMENT 4**

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Moderate)***
2. Sites Impacted by railway corridor	
▪ Time delays and additional construction costs to develop.	▪ Include TfNSW and Railcorp on the UAP working group to ensure coordination in the future delivery of potential transport interchange. ▪ The Herring Road UAP masterplan include details of the Herring Road bus interchange ▪ Increased coordination with transport authorities on the timeline of Parramatta to Macquarie Park light rail connection. ▪ Council continue to be updated on the progress of a feasibility study for the Parramatta to Macquarie Park light rail link initiated by Parramatta Council

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Moderate)***
3. Exclusion of Herring Road UAP	
▪ Expected shortfall in infrastructure funding for future roads and parkland. ▪ Residential creep towards Macquarie Park.	▪ A working group with State Government currently exists however the scope of this arrangement relates the preparation of the UAP. The working group would need to go beyond the current scope to ensure cross boundary coordination particularly in relation to the delivery of infrastructure in the broader Macquarie Park. ▪ A low take-up of the incentive scheme would impact Council's revenue from the additional FSR however this would be partially offset by a lower requirement for infrastructure provision and lower cost. Further analysis should be carried out to determine the financial impacts of the shortfall. ▪ When exhibited, Council undertake a review of the Herring Road UAP plans to determine the impact on the Macquarie Park Planning Incentive Scheme.

Risk / Issue (Inherent Risk – Moderate)	***Mitigation (Projected Risk – Minor)***
4. Status of White Paper and Planning Bill	
▪ Uncertainty of use and form of VPA's	▪ Regular liaison with the State Government on the status of the Planning Bill.

ITEM 6 (continued) **ATTACHMENT 4**

4.2 Timing Risk

Risk / Issue (Inherent Risk – Major)	Mitigation (Projected Risk – Moderate)
1. Delay in timing of Contributions	
▪ The timing of payments based on Present Value has a potential to lead to a significant shortfall in capital funding for infrastructure.	▪ Due to the development horizon associated with the infrastructure roll out, the costing of infrastructure be indexed to account for escalating construction costs. The Building Price Index (BPI)[2] is recommended as this mimics change in construction cost. ▪ Prepare a high-level staging plan based on known landowner intentions and catalyst infrastructure. This will give landowners some guidance as to the future rollout of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop.

Risk / Issue (Inherent Risk – Major)	Mitigation (Projected Risk – Moderate)
2. Delay in infrastructure delivery	
▪ Blow-out of development horizon period. ▪ Bonus FSR only realised towards the end of the project leading to delay in infrastructure provision. ▪ Missing links in future road network due to pattern of landowner take-up.	▪ Where applicable, utilise section 94 contributions for staged developments to offset early provision of infrastructure. ▪ Prepare a high-level staging plan based on known landowner intentions and catalyst infrastructure. This will give landowners some guidance as to the future rollout of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop. ▪ Council schedule a review of the Planning Incentive Scheme and its progress 10 years after coming into effect. Consider appropriate planning mechanisms to address any delay in infrastructure delivery.

[2] ABS Output of Construction Industries Index

ITEM 6 (continued) **ATTACHMENT 4**

4.3 Financial Risk

Risk / Issue (Inherent Risk – Major)	*Mitigation (Projected Risk – Moderate)*
1. Compensation for infrastructure affected land	
▪ Development not proceeding due to sites not being economically viable	▪ Feasibility modelling was previously undertaken by Hill PDA to determine overall viability of sites. This information formed the basis for the rates included in the Planning Incentives Scheme. Independent advice may be sought as part of future VPA negotiations.

Risk / Issue (Inherent Risk – Moderate)	*Mitigation (Projected Risk – Minor)*
2. Future maintenance of assets	
▪ Insufficient funds to maintain assets	▪ Council review the value ascribed to land to be dedicated for new roads and parks, factoring the cost of maintenance. ▪ Where appropriate, Council utilise the Macquarie Park Special Rate Levy to meet the on-going cost of maintenance

ITEM 6 (continued) **ATTACHMENT 4**

4.4 Market Risk

Risk / Issue ***(Inherent Risk – Major)***	***Mitigation*** ***(Projected Risk – Moderate)***
1. Economic Climate	
▪ Development not proceeding in the short term	▪ Review FSR bonus levy periodically, for example every 3-5 years to ensure the levy aligns with market movements and that redevelopment remains an attractive proposition even during tough economic conditions.

Risk / Issue ***(Inherent Risk – Major)***	***Mitigation*** ***(Projected Risk – Moderate)***
2. Uptake of bonus FSR	
▪ Development not proceeding due to sites not being viable. Key infrastructure not delivered in a timely manner.	▪ Council convenes the Macquarie Park Forum which provides open communication between the Council and developers. The forum draws representation from landowners, the Property Council, the Macquarie Park Transport Management Association and local residents. ▪ Recognition that some sites do not present short or medium term development propositions. High level staging plan should be cognisant of this. ▪ Based on approved DAs and VPAs, carry out site audit to determine those sites which are ready for development. From this identify timing of infrastructure to support individual precincts.

ITEM 6 (continued) **ATTACHMENT 4**

4.5 Delivery Risk

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Minor)***
1. Uncertainty of infrastructure delivery	
▪ Parkland works do not proceed and the vision for Macquarie Park is not realised	▪ Council to review infrastructure delivery at year 10 and consider planning mechanisms to address delayed delivery of infrastructure ▪ Council to create an infrastructure reserve specifically for Macquarie Park which commits future monies to the provision of infrastructure within this area.

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Moderate)***
2. Piecemeal delivery of infrastructure	
▪ Inconsistencies in delivery outcomes. ▪ Developer uncertainty of timing and delivery of specific items and whether payments will be expended within Macquarie Park.	▪ A schedule of works is allocated to each parcel of land to allow the landowner to assess its obligations in redeveloping each site. This also allows works in kind to be valued for the purposes of the VPA. ▪ Council convenes the Macquarie Park Forum which provides open communication between the Council and developers. The forum draws representation from landowners, the Property Council, the Macquarie Park Transport Management Association and local residents. ▪ DCP controls are in place within Macquarie Park for all future roads and parklands. The DCP will be amended once current amendments have been approved by the Council.

Risk / Issue (Inherent Risk – Major)	***Mitigation (Projected Risk – Moderate)***
3. Coordination across site boundaries	
▪ Disjointed road network through lack of coordination in design	▪ Carry out detailed design of future roads to determine the extent of site impact from future infrastructure provision

- Future DAs will need to consider cross level adjustments between sites.
- Carry out a road constructability audit at the completion of the works to ensure quality control.

Risk / Issue ***(Inherent Risk – Moderate)***	***Mitigation*** ***(Projected Risk – Minor)***
4. Council resourcing and administration	
▪ Poor coordination and lack of direction in managing the future roll-out of the project	▪ Council appoints a dedicated contributions coordinator to manage Section 94 and VPA negotiations.

Risk / Issue ***(Inherent Risk – Moderate)***	***Mitigation*** ***(Projected Risk – Minor)***
5. Future land tenure	
▪ Proposed roads and open spaces not being dedicated to Council under the provisions of the VPA	▪ Ensure all future public infrastructure is dedicated to Council by way of development condition. ▪ In the case of land-locked sites the onus is on the developers to maintain infrastructure until the land is accessible.

5. Summary of Recommendations

The Risk Management Plan has been summarised as a comprehensive Project Risk Register (at Appendix 1).

Based on the risk management plan, it is recommended Council take the following key steps to help minimise the risks associated with the Planning Incentive Scheme for Macquarie Park.

Infrastructure Staging

- Prepare a high level staging plan based on landowner dialogue and intentions, development approvals and executed VPAs. This will give other landowners some guidance as to the future rollout of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop.
- Based on approved DAs and VPAs, carry out site audit to determine those sites which are ready for development. From this identify timing of infrastructure to support individual precincts.
- Subject to budgetary constraints, carry out detailed design of future roads which are likely to be delivered in a 2-3 year development horizon.
- Review infrastructure delivery at year 10 and consider planning mechanisms to address delayed delivery of infrastructure
- Create an infrastructure reserve specifically for Macquarie Park which commits future monies to the provision of infrastructure within this area

Stakeholder and Landowner Engagement

- Expand the scope of the existing UAP working group with State Government to ensure cross boundary coordination particularly in relation to the delivery of infrastructure.
- Carry out further analysis of the funding shortfalls and undelivered infrastructure associated with the Herring Road UAP
- Include TfNSW and Railcorp on the UAP working group to ensure coordination in the future delivery of potential transport interchange.
- Maintain an on-going dialogue with key development players on the form and nature of individual voluntary planning agreements.
- Actively engage landowners on an on-going basis.
- Commence VPA discussions early by way of the formal pre-lodgement process for major developments.
- Maintain an on-going dialogue with the State Government on the status of the White Paper and Planning Bill.

Guidelines and Certainty for Development

- Establish a schedule of works for each development parcel to identify individual developer obligations for each site.
- Ensure all future public infrastructure is dedicated to Council by way of development condition. For land-locked sites, condition the developer.
- Adopt the Building Price Index (BPI) as a preferred indexation method when providing for escalating costs of infrastructure.
- Review FSR bonus levy periodically to ensure it aligns with market conditions as they change, to ensure redevelopment remains an attractive proposition even during tough economic conditions.
- Amend DCP once current changes have been approved by the Council.

Lifecycle Costs

- Council review the value ascribed to land to be dedicated for new roads and parks, factoring the cost of maintenance
- Where appropriate, Council utilise the Macquarie Park Special Rate Levy to meet the on-going cost of maintenance

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5. Due care has been taken to prepare the attached financial models from available information at the time of writing, however no responsibility can be or is accepted for errors or inaccuracies that may have occurred either with the programming or the resultant financial projections and their assumptions.

6. This report does not constitute a valuation of any property or interest in property. In preparing this report Hill PDA has relied upon information concerning the subject property and/or proposed development provided by the Client and Hill PDA has not independently verified this information except where noted in this report.

7. In relation to any valuation which is undertaken for a Managed Investment Scheme (as defined by the Managed Investments Act 1998) or for any lender that is subject to the provisions of the Managed Investments Act, the following clause applies:

8. This valuation is prepared on the assumption that the lender or addressee as referred to in this valuation report (and no other) may rely on the valuation for mortgage finance purposes and the lender has complied with its own lending guidelines as well as prudent finance industry lending practices, and has considered all prudent aspects of credit risk for any potential borrower, including the borrower's ability to service and repay any mortgage loan. Further, the valuation is prepared on the assumption that the lender is providing mortgage financing at a conservative and prudent loan to value ratio.

Appendix 1 - RISK MANAGEMENT PLAN

ITEM 6 (continued) **ATTACHMENT 4**

Macquarie Park Project - Risk Management Plan

Step A and B : Risk Categories				Step C: Inherent Risk Assessment				Step D: Treat the Risks							Step D: Projected Risk Assessment		
Risk No.	Source of Risk	Risk	Risk Consequence	Likelihood	Consequence	Risk Rating (LxC)	Risk Owner	Cotrol Subset	Risk Controls or Mitigation Strategies	Completion Target Date	Mitigation Strategy owner	Control Implemented	Comments	Status	Likelihood	Consequence	Risk Rating (LxC)
1	A. Planning Risk	Executions of Voluntary Planning Agreements (VPAs)	Development does not proceed.	4	3	Major	City of Ryde	(i)	VPA discussions to commence early by way of the formal pre-lodgement process for major developments. Generally, VPAs are agreed between the developer and Council prior to DA being reported to planning authority.	Ongoing	City of Ryde				3	3	Moderate
								(ii)	Council has adopted a VPA template and policy to promote an equitable and transparent process. In addition, a separate VPA committee has successfully operated for the last 5 years. This Committee is chaired by Council's Legal Counsel and engages independent advice if necessary.	Ongoing	City of Ryde						
								(iii)	Where appropriate, Council engages QS to advise/verify VPA offers in relation to their community benefit.	Ongoing	City of Ryde						
2	A. Planning Risk	Sites impacted by railway corridor	Time delays and additional construction costs to develop.	3	4	Major	City of Ryde	(i)	Include TfNSW and Railcorp on the UAP working group to ensure coordination in the future delivery of potential transport interchange	2013-2014	City of Ryde				2	3	Moderate
								(ii)	The Herring Road UAP masterplan include details of the Herring Road bus interchange	Ongoing	City of Ryde						
								(iii)	Council continue to be updated on the progress of a feasibility study for the Parramatta to Macquarie Park light rail link initiated by Parramatta Council	Ongoing	City of Ryde						
								(iv)	Increased coordination with transport authorities on the timeline of Parramatta to Macquarie Park rail connection. Identify those sites potentially affected.	2013-2014	City of Ryde						
3	A. Planning Risk	Exclusion of Herring Road UAP	Expected shortfall of developer contributions to fund future infrastructure. Residential creep into the development area.	4	4	Major	City of Ryde	(i)	A working group with State Government currently exists however the scope of this arrangement relates the preparation of the UAP. The working group would need to go beyond the current scope to ensure cross boundary coordination particularly in relation to the delivery of infrastructure.	2013-2014	City of Ryde		Working group should meet at least monthly		3	3	Moderate
								(ii)	When exhibited, Council undertake a review of the Herring Road UAP plans to determine the impact on the Macquarie Park Planning Incentive Scheme	2013-2014	City of Ryde						
								(iii)	A low take-up of the incentive scheme would impact Council's revenue from the additional FSR however this would be partially offset by a lower requirement for infrastructure provision and lower cost. Further analysis should be carried out to determine the financial impacts of the shortfall	2014-2015	City of Ryde		Council recommendation that a consultant be appointed to carry out further work to determine the financial impact of the Herring Road UAP.				
4	A. Planning Risk	Status of White Paper and Planning Bill	Uncertainty of use and form of VPA's	3	3	Moderate	City of Ryde	(i)	Regular liaison with the State Government on the status of the Planning Bill	2013-2014	City of Ryde		Hill PDA understands the VPA's will continue albeit in a different form		2	2	Minor
5	B. Timing Risk	Delay in timing of contributions	Development does not proceed. Timing of payments based on present value has the potential to lead to a shortfall in capital expenditure for infrastructure	4	4	Major	City of Ryde	(i)	Due to the development horizon associated with the infrastructure roll out, the costing of infrastructure be indexed to account for escalating construction costs. The Building Price Index (BPI) is recommended as this mimics change in construction cost	2013-2014	City of Ryde				3	3	Moderate
								(ii)	Council to prepare a high level staging plan based on development approvals and executed VPAs. This will give landowners some guidance as to the future roll out of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop	2014-2015	City of Ryde		This document is effectively an implementation strategy or road map to provide clarity and some guidance on the roll out of the development. If need be, precincts that develop beyond the 20 year period should be identified.				
6	B. Timing Risk	Timing of infrastructure delivery	Blow out of development horizon period. Bonus FSR only realised towards the end of the project leading to further delay. Missing links in future road network.	4	4	Major	City of Ryde	(i)	Where applicable, utilise section 94 contributions for staged developments to offset early provision of infrastructure	2014-2015	City of Ryde				3	3	Moderate
								(ii)	Council schedule a review of the Planning Incentive Scheme and its progress 10 years after coming into effect. Consider appropriate planning mechanisms to address any delay in infrastructure delivery	2023-2024	City of Ryde						
								(iii)	Council to prepare a high level staging plan based on development approvals and executed VPAs. This will give landowners some guidance as to the future roll out of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop	2014-2015	City of Ryde		This document is effectively an implementation strategy or road map to provide clarity and some guidance on the roll out of the development. If need be, precincts that develop beyond the 20 year period should be identified.				
7	C. Financial Risk	Compensation for infrastructure affected land	Development not proceeding due to sites not being viable	4	3	Major	City of Ryde	(i)	Feasibility modeling was previously undertaken by Hill PDA to determine overall viability of sites. This information formed the basis for the rates included in the Planning Incentives Scheme. Independent advice may be sought as part of future VPA negotiations	Ongoing	City of Ryde				3	3	Moderate
8	C. Financial Risk	Future maintenance of assets	Insufficient funds to maintain assets	3	3	Moderate	City of Ryde	(i)	Council review the value ascribed to land to be dedicated for new roads and parks, factoring the cost of maintenance	2014-2015	City of Ryde				2	2	Minor
								(ii)	Where appropriate, Council utilise the Macquarie Park Special Rate Levy to meet the on-going cost of maintenance	2014-2015	City of Ryde						
10	D. Market Risk	Current economic climate	Development not proceeding in the short term	4	3	Major	City of Ryde	(i)	Review FSR bonus levy periodically (3-5 years) and recognise that markets are cyclical in their nature and subject to change	Ongoing	City of Ryde				3	2	Moderate
11	D. Market Risk	Uptake of bonus FSR	Development not proceeding due to sites not being viable. Key infrastructure not delivered in a timely manner	4	4	Major	City of Ryde	(i)	Council convenes the Macquarie Park Forum which provides open communication between the Council and developers. The forum draws representation from landowners, the Property Council, the Macquarie Park Transport Management Association and local resident	2014-2015	City of Ryde				3	3	Moderate
								(ii)	Recognition from Council that some sites are not suitable for development at present. High level staging plan should be based on this premise	Ongoing	City of Ryde						
								(iii)	Based on approved DAs and VPAs, carry out site audit to determine those sites which are ready for development. From this identify timing of infrastructure to support individual precincts.	2014-2015	City of Ryde						
12	E. Delivery Risk	Uncertainty of infrastructure delivery	Parkland works do not proceed and the vision for Macquarie Park is not realised	4	3	Major	City of Ryde	(i)	Council to review infrastructure delivery at year 10 and consider planning mechanisms to address delayed delivery of infrastructure	2014-2015	City of Ryde				2	2	Minor

J:\Jobs-Current\C14032 - Macquarie Park VPA Risk Assessment and Management Plan\Risk Management Table\
Macquarie Park Risk Assessment Table

Page 2

Version 1.4
Last Updated 17/10/2008

ITEM 6 (continued) **ATTACHMENT 4**

Risk No.	Source of Risk	Risk	Risk Consequence	Likelihood	Consequence	Risk Rating (LxC)	Risk Owner	Cotrol Subset	Risk Controls or Mitigation Strategies	Completion Target Date	Mitigation Strategy owner	Control Implemented	Comments	Status	Likelihood	Consequence	Risk Rating (LxC)
Step A and B : Risk Categories				Step C: Inherent Risk Assessment					Step D: Treat the Risks						Step D: Projected Risk Assessment		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	(ii)	Council to create an infrastructure reserve specifically for Macquarie Park which commits future monies to the provision of infrastructure within this area	2014-2015	City of Ryde						
13	E. Delivery Risk	Piecemeal delivery of infrastructure	Inconsistencies in delivery outcomes. Developer uncertainty of timing and delivery of specific items and whether payments will be expended within MP.	4	4	Major	City of Ryde	(i)	A schedule of works be allocated to each parcel of land to allow the landowner to assess its obligations in redeveloping each site. This also allows works in kind to be valued for the purposes of the VPA	2014-2015	City of Ryde				3	3	Moderate
								(ii)	Council convenes the Macquarie Park Forum which provides open communication between the Council and developers. The forum draws representation from landowners, the Property Council, the Macquarie Park Transport Management Association and local resident	2014-2015	City of Ryde						
								(iii)	Council to prepare a high level staging plan based on development approvals and executed VPAs. This will give landowners some guidance as to the future roll out of the Macquarie Park precinct. As part of this process engage with landowners with regards to their intentions and plans to re-develop	2014-2015	City of Ryde		This document is effectively an implementation strategy or road map to provide clarity and some guidance on the roll out of the development. If need be, precincts that develop beyond the 20 year period should be identified				
								(iv)	DCP controls are in place within Macquarie Park for all future roads and parklands. Architectus currently working on refining these controls. The DCP will be amended once the amendments have been approved by the Council.	2014-2015	City of Ryde		It is preferential to address building envelopes by way of the DCP and the Local Environment Plan because of the obligation to compulsory acquire				
14	E. Delivery Risk	Coordination across site boundaries	Disjointed road network through lack of coordination in design	3	4	Major	City of Ryde	(i)	Carry out detailed design of future roads to determine the extent of site impact from future infrastructure provision	Ongoing	City of Ryde				2	3	Moderate
								(ii)	Ensure future DA's have due regard to design drawings particularly in relation to cross level adjustments between sites	Ongoing	City of Ryde		Dedicated officer identified in risk 15 should be involved with future DA's in this regard				
								(iii)	Carry out a road constructability audit at the completion of the works to ensure quality control	Ongoing	City of Ryde						
15	E. Delivery Risk	Council resourcing and administration	Poor coordination and lack of direction in managing the future roll-out of the project	3	3	Moderate	City of Ryde	(i)	Council has appointed a dedicated contributions coordinator to manage Section 94 and VPA negotiations	Complete	City of Ryde				2	2	Minor
16	E. Delivery Risk	Future land tenure	Proposed roads and open spaces not being dedicated to Council under the provisions of the VPA	3	3	Moderate	City of Ryde	(i)	Ensure all future public infrastructure is dedicated to Council by way of a a development condition. In this case of land-locked sites the onus needs to be on the developers to maintain the infrastructure until the land is fully accessible	Ongoing	City of Ryde				2	2	Minor

Risk Response Priorities

Decisions to accept and control, reduce or avoid identified risk must follow the guidelines below.

	Key	Response
Severe	20-25	Unacceptable level of risk exposure which requires immediate corrective action to be taken
Major	12-16	Unacceptable level of risk exposure which requires constant active monitoring and measures to be put in place to reduce exposure
Moderate	5-10	Acceptable level of risk exposure subject to regular active monitoring measures
Minor	3-4	Acceptable level of risk subject to regular passive monitoring measures
Insignificant	1-2	Acceptable level of risk subject to periodic passive monitoring measures

Risk Treatment	
Risk Treatment strategies chosen to control or reduce identified risks must be:	
S =	Specific
M =	Measurable
A =	Agreed
R =	Realistic
T =	Timebound

Risk Treatment Status

X	Mitigation Strategy has not been implemented / risk is not under control.
?	Risk treatment is not sufficient or is likely to fail ; the risk may become uncontrollable if treatment is not improved.
√	Mitigation Strategy has been implemented successfully and risk is being controlled.

LIKELIHOOD	Multiplier	CONSEQUENCE (impact / severity): Catastrophic 5	Major 4	Moderate 3	Minor 2	Insignificant 1
Almost Certain	5	Severe (25)	Severe (20)	Major (15)	Moderate (10)	Moderate (5)
Likely	4	Severe (20)	Major (16)	Major (12)	Moderate (8)	Minor (4)
Possible	3	Major (15)	Major (12)	Moderate (9)	Moderate (6)	Minor (3)
Unlikely	2	Moderate (10)	Moderate (8)	Moderate (6)	Minor (4)	Low (2)
Rare	1	Moderate (5)	Minor (4)	Minor (3)	Low (2)	Low (1)

Risk Tolerance Level

Page 2

J:\Jobs-Current\C14032 - Macquarie Park VPA Risk Assessment and Management Plan\Risk Management Table\ Macquarie Park Risk Assessment Table

Version 1.4
Last Updated 17/10/2008

ITEM 6 (continued) **ATTACHMENT 4**

Step A and B : Risk Categories				Step C: Inherent Risk Assessment					Step D: Treat the Risks						Step D: Projected Risk Assessment		
Risk No.	Source of Risk	Risk	Risk Consequence	Likelihood	Consequence	Risk Rating (LxC)	Risk Owner	Cotrol Subset	Risk Controls or Mitigation Strategies	Completion Target Date	Mitigation Strategy owner	Control Implemented	Comments	Status	Likelihood	Consequence	Risk Rating (LxC)

Pilot Trial of Personal Mobility Devices at Macquarie University

Report Prepared for the PMD Project Steering Committee, August 2013

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Acknowledgments

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Executive Summary

Personal Mobility Devices (PMDs) are small, motorised devices designed to transport individuals. From July 2012 to June 2013, the City of Ryde, in partnership with researchers from the Macquarie University Transport Group, initiated and conducted a trial of three different Personal Mobility Devices (PMDs). The trial aimed to evaluate:

1. Rider perceptions and experiences of PMD use.
2. Pedestrian interactions with PMD riders.
3. Infrastructure requirements and operating parameters for PMD use.
4. An appropriate research design to provide input into further PMD research.

The trial used three PMD types: a two-wheeled PMD, a gyro-stabilised three-wheeled PMD, and a gyro-stabilised one-wheeled PMD. A trial of these three PMD types was conducted on the Macquarie University campus, using university staff as riders under actual conditions of use on shared access footpaths.

The trial was conducted over nine weeks, using 17 participants riding a device a week. Two participants rode three devices over the trial period, nine rode two devices and six rode one device. Questionnaires were administered to riders both pre- and post-use. Actual usage (speed, number of trips, distance travelled) was monitored through GPS tracking. Pedestrians within the Macquarie University campus were also questioned about their experience of sharing the footpaths with PMDs riders. Interactions between pedestrians and PMDs were also monitored by closed circuit television cameras at four sites on the campus.

Of the 11 participants who trialled several PMDs, eight nominated the two-wheeled PMD as most effective in terms of flexibility. In contrast, six participants evaluated the three-wheeled PMD as most effective in terms of speed. One-wheeled PMD riders were enthused with their device, especially with the speed, however, significant training and practise was required. Two-wheeled PMD riders had less difficulty navigating through pedestrian precincts and with the manoeuvrability of the device. The relative narrowness of the two-wheeled PMD made it easier to use on a diversity of path widths.

The trial was successful. This report presents key findings of the research in terms of five dimensions as follows:

1. Induction and training : Training in PMD use for research purposes is necessary and should incorporate navigational skills, avoiding static and moving objects, and interaction with unobservant pedestrians. Training should provide riders with the opportunity to practice on sloping and uneven surfaces.

2. Operating conditions : PMDs typically travelled around campus between a fast walking pace and easy jogging (6-8 km/h) and for trip lengths of between 500 and 1,000 metres. This would seem to indicate that distance travelled can be enhanced

through PMD use, complementing walking or cycling. Assistance with way-finding through signage, however, may be necessary to denote appropriate and convenient routes that PMD riders may choose for travel to different destinations (avoiding stairs, overly rough surfaces, etc.).

3. Pedestrian interactions : The overwhelming majority of campus users were comfortable with and welcoming of the use of PMDs in pedestrian environments. In a university environment, on predominantly shared paths and with a limited number of PMDs, pedestrians and PMDs interacted harmoniously. PMD use is largely compatible with existing road and pedestrian infrastructure, especially for the lighter and narrower devices.

4. Rider experiences: All riders found PMDs easier to use with practice. All riders of the two-wheeled device found it easy to use, while one sixth of three-wheeler PMD riders found the device hard to use. Riders reported that the usability of all PMDs was compromised by the weight of the devices, portability and parking, and difficulties with hills. Most riders indicated a willingness to use PMDs off campus or to public transport hubs if available. Some participants were observed to use a PMD less over the trial period. They reported that this was as their trips were short distances and walking was more convenient as the PMDs were too heavy and they had problems with parking or storage.

5. Design of future research: This was a limited trial, with a small number of participants and in a unique environment. Consequently, these findings are not generalisable in the scientific sense and cannot underpin widespread recommendations for change to regulatory frameworks of PMDs. However, the suitability of the university as a trial site for PMDs was confirmed.

Based on these general findings, the following recommendations are proposed:

Recommendation 1: That the trial be extended into the Macquarie Park precinct. This extension should be aligned with the strategic plans of, and collaboration with, relevant agencies (e.g. Transport for NSW, City of Ryde, Macquarie Park Transport Management Association) and invite collaboration from any business or businesses in the precinct who wish to explore alternative transport options for their staff.

Recommendation 2: An extended trial be limited to use of light, narrow and portable PMDs, such as two-wheeled PMDs, on footpaths with appropriate speed limiting to no more than 10 km/h; consideration may also be given to other PMDs which may be used on public roads with higher speed limiting as appropriate.

Recommendation 3: Further controlled experimentation be conducted on the Macquarie University campus to examine the interaction between PMDs, as well as the interactions of multiple PMDs with pedestrians in light and congested densities.

Recommendation 4: A review of regulatory and insurance issues, and product standards as applicable to PMDs (rather than other alternative vehicles) be undertaken.

Notwithstanding, the evidence gathered in this trial suggests that any consideration of regulating PMDs and their use needs to take into account:

- Further examination of appropriate means of speed limiting,
- Training for PMD riders is advisable,
- Education of both pedestrians and riders about shared paths is recommended.

Glossary and Abbreviations

For the purposes of this report the following definitions are used.

Accessible Path

A continuous accessible path of travel that shall not include a step, stairway, turnstile, revolving door, escalator, moving walk or other impediment.

Alternative Vehicle (AV)

Those vehicles and devices that are not defined in the Australian Road Rules or other relevant road transport legislation as pedestrians, bicycles, motorcycle or motor vehicles.

Assistive Technology (AT)

Those assistive, adaptive, and rehabilitative devices for people with disabilities. Assistive technology can include mobility devices such as walking sticks, crutches, walkers, and manual and electric wheelchairs. In the wider sense, assistive technology encompasses a variety of types, including hardware, software, and peripherals that assist people with disabilities in accessing computers or other information technologies, as well as screen readers, magnifiers, alternative input, text-to-speech, speech recognition, and Braille readers.

Australian Road Rules (ARR)

The Australian Road Rules contain the basic rules of the road for motorists, motorcyclists, cyclists, pedestrians, passengers and others, including the operators of personal mobility devices (PMDs) and other alternative vehicles (AVs). They are 'model laws' that were initially created in 1999 under an agreement under which each Australian state and territory agreed that it would adopt the Rules into its laws. In New South Wales, the Australian Road Rules (and other additional local road rules) are given effect through the NSW Road Rules 2008.

Gyroscope

A device for measuring or maintaining orientation, based on the principles of angular momentum.

Path dimension

The width of a footpath. A width of 1.5-1.8 m should be the minimum for pedestrian facilities for mobility impaired pedestrians

Pedestrian

Any person going on foot in a pedestrian zone. A pedestrian includes a person driving a motorised wheelchair that cannot travel at over 10 kilometres per hour (on level ground); a person in a non-motorised wheelchair, and a person in or on a wheeled recreational device or wheeled toy.

Pedestrian Zones

These include footpaths, bicycle paths, intersections and the shoulders of roads where speed limits of 10 km/h or less are posted.

Personal Mobility Device (PMD)

A small, lightweight electrical device, other than an assistive technology medical device or an all-terrain vehicle, with one, two (or three) wheels, designed to be driven in a standing position, whose maximum speed is not in excess of 10 km/h. The abbreviation PMD used in this report refers **only** to the Egret One, Qugo or Solowheel.

Public roads and paths

Roads and road-related areas, as defined in the NSW Road Rules 2008. Also known as roads and footpaths

Roads and footpaths

See Public roads and paths.

Road users

A driver, rider, passenger or pedestrian. Currently, under the Australian Road Rules, operators of alternative vehicles (including riders of personal mobility devices) are not identified as a separate category of road user.

Shared Path

An area open to the public (except a separated footpath) that is designated for, or has as one of its main uses, use by both bicycle riders and pedestrians, and includes a length of path intended for use by both bicycles and pedestrians beginning and ending with a shared path sign or shared path road marking.

Shared Zone

A length of road designated for, or has as one of its main uses, use by both pedestrians and drivers of motor vehicles, beginning and ending with a shared zone sign or shared zone road marking. A driver driving in a shared zone must give way to any pedestrian in the zone.

Vehicle

Includes:

- A motor vehicle, trailer and light rail vehicle (tram),
- A motorcycle,
- A bicycle,
- An animal-drawn vehicle, and an animal that is being ridden or drawing a vehicle,
- An alternative vehicle, including a motorised wheelchair, personal mobility device, motorised mobility scooter or other motorised device that can travel at over 10 kilometres per hour (on level ground), but does not include a manual wheelchair, a train, or a wheeled recreational device or wheeled toy.

Table of Contents

ITEM 10 (continued) **ATTACHMENT 1**

List of Tables

List of Figures

Introduction

One of the key dilemmas facing policy attempts to reduce private car use is their use in journeys less than five kilometres long. The preponderance of vehicle-based short trips in suburban areas (e.g. Ryde) and suburban business parks (e.g. Macquarie Park) create congestion, road safety risks and numerous other externalities. Personal Mobility Devices (PMDs) – electric, motorised or motor-assisted devices – may offer one solution to this first and last mile dilemma as they enable riders to travel short distances quickly and to transfer between transport modes. PMD use is not approved or widespread in Australia, and there is no evidence that considers the viability – especially in terms of usability and safety – of these devices in the Australian situation. This research project begins to redress this lack of evidence.

The Macquarie University campus is a confined site with a well-defined path system that makes it ideal for the trial. Through a trial of PMD use on the Macquarie campus it aimed to:

1. Trial the use of PMDs in a controlled site to allow evaluation of usage patterns by a range of riders.
2. Provide information on the use of PMDs as input into development of licensing and registration policy in NSW and Australia.
3. Produce implementation guidelines informed by the results of the trial to be used by Australian Local Governments willing to implement the use of PMDs.

The practicalities of the research design, delays beyond the control of the research team and available expertise led to the modified aims as below:

1. Rider perceptions and experiences of PMDs.
2. Pedestrian perceptions of PMDs.
3. Infrastructure and operating parameters of PMD use.
4. An appropriate research design to provide input into further research.

This report presents the research results of Phase 1 of the trial in terms of the four aims above. Where relevant it refers to, but does not include, supporting documents prepared as part of the project, including literature review, assessment of infrastructure and selection of the devices. The body of the report focuses on research results in terms of the four aims above.

Background

Regulatory Context of Personal Mobility Devices

The number of non-registered motorised vehicles that provide the possibility of alternative travel within the road transport system is increasing with developments in both electrical propulsion technologies and digital electronics. Such wheeled vehicles that are used for personal transport but differ in construction from conventional vehicles such as cars, motorcycles and bicycles and cannot comply with applicable Australian Design Rules (ADRs) for cars or motorcycles.

Many of these vehicles are aimed at meeting the needs of people with a mobility-related disability where the provision of alternative transport options might be considered essential, and are thus generally permitted for use within the road transport system provided they are used on footpaths and meet regulatory restrictions concerning size, weight and maximum speed.

However, there is a category of non-registered motorised vehicles that is designed to supplement transport options that are already permitted within the road transport system (e.g. walking, buses, or light rail) or to replace the use of personal cars for short trips and first-and-last mile of travel during commuting (Faulks, Irwin, Howitt, Dowling & Zarafu, 2013). This category, referred to as personal mobility devices (PMDs), is more aligned with the use of bicycles than as assistive technologies for people with disabilities, and interest in these types of vehicles primarily relates to their proposed benefits for reductions in pollution and traffic congestion.

PMDs are motor-assisted, low-speed, lightweight devices with one, two, three or four wheels [see: http://www.youtube.com/watch?v=q3kzJCCiWIc]. They are designed to transport one person on footpaths, shared use paths, cycleways and trails.

Determination of the legal status of a particular non-registered motorised vehicle can be difficult, as there is no accepted regulatory framework for these devices in Australia. In some jurisdictions motorised scooters are legal providing they cannot travel at more than 10 km/h and their motor does not exceed 200 watts power output; and if their motor is under 200 watts they can be imported into Australia without requiring special import approval. In NSW, PMDs are a form of motor vehicle and are subject to the same legislation as motor vehicles. In NSW, motor vehicles must be registered for use on a road or road-related area unless it is specifically exempt (for example, motorised wheelchairs and power assisted pedal cycles are exempt). As it stands, the motorised wheelchairs – if adjudged to be able to access the road transport system legally – are treated as 'pedestrians' if they cannot travel at speeds higher than 10 km/h on level ground.

Currently PMDs do not meet the minimum Australian design standards for safety and so cannot be registered in NSW. This means they must not be used on roads or in any public areas such as footpaths, car parks and parks. Special allowances have been made by the NSW Government in order for this trial to occur legally on the Macquarie University campus.

There are a number of other studies relevant to this project. Austroads has attempted to develop a general framework for alternative vehicles (Paine, Paine, Faulks, Griffiths & Bailey, 2010; see also Paine, 2011), but was unable to secure the unanimous agreement of all Australian jurisdictions and New Zealand. Currently, there is a research project underway that is attempting to establish an acceptable framework specifically for electric wheelchairs and motorised mobility devices (Paine, Paine, Faulks & Griffiths, 2013), and this project, if successful, may pave the way to a more general regulatory structure for all alternative vehicles.

In October 2012, the Commonwealth Department of Infrastructure and Transport released a discussion paper, *Walking, Riding and Access to Public Transport*. The discussion paper noted that when the terms walking and riding were used in the paper, they generally referred to any form of human powered mobility, such as walking on two feet; using a wheelchair or other personal mobility device; pushing a pram or wheeling luggage; riding a bicycle, e-bike/pedelec, scooter, skateboard, tricycle or rollerblades. The discussion paper drew a substantial number of submissions, notably from many local government areas across Australia. After consideration of submissions, a final report was published in July 2013. The report provides a comprehensive analysis of the barriers and opportunities for walking, riding and access to public transport, but did not specifically examine the use of PMDs as alternatives to walking and cycling.

In NSW, the parliamentary Joint Standing Committee on Road Safety (the Staysafe Committee) is holding an inquiry into the increasing use of non-registered motorised vehicles, including PMDs, mobility scooters, electric bicycles, Segways and quad bikes on public roads, footpaths and public land and their impact on road safety. The Committee has held several public hearings and has examined issues regarding this PMD trial. The Committee has announced that it expects to report its findings and recommendations by the end of 2013.

The development of a regulatory system for alternative vehicles must be undertaken with care, as seemingly simply solutions may have unanticipated effects on the road transport system and across the general community. It is in this regulatory context that this project sits. Its purpose as a pilot research project and its very small sample size means that it explicitly cannot make direct policy recommendations. Instead, the research identifies appropriate means of evaluating PMDs in real world contexts, and indicates issues that emerge when PMDs are used in pedestrian environments.

ITEM 10 (continued) **ATTACHMENT 1**

Background to the PMD Trial

The trial was one component of a larger project instigated by the City of Ryde and jointly funded by Macquarie University and the City of Ryde through an Enterprise Partnership Grant. The elements of the broader project are summarised in Figure 1 and those relevant to this research report described below.

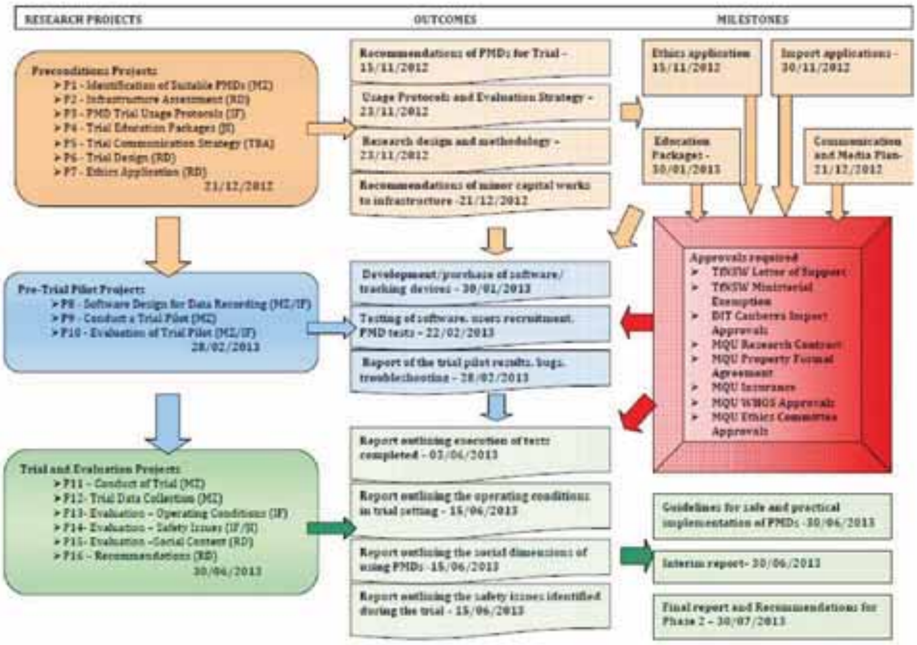

Figure 1: Projects Surrounding the PMD Trial

Trial Preparation

Preparation for the trial was lengthy and involved because of the regulatory context described above. Preparation was overseen by a Project Steering Committee, comprising key stakeholders from the university, the City of Ryde and Transport for NSW. Prior to the trial commencing, the steering committee met monthly to discuss and approve elements of the trial design and to facilitate the required approvals. The key points are as follows:

Selection of PMDs for trial

An initial subproject evaluated different PMDs and developed a set of criteria for the selection of suitable PMDs for Phase 1 of the trial. The criteria for selection focused on the safety for riders and others riders of the shared use paths, considering performance parameters of the devices, but also the Road Rules 2008 to where these devices would be ridden. Criteria were established based on analysing the potential risk of injury to the riders and other path users, which was directly related to the kinetic energy, but also the potential risk of back injury if the rider was to lift or carry the device. The kinetic energy is proportional to the mass (rider + vehicle) and the square of velocity. Given this, the most effective way to reduce kinetic energy is by reducing the speed. Assuming that the pedestrian weight is in the normal range of 60-90 kg, the pedestrian speed before impact is 6 km/h and the PMD's speed before the impact is 10 km/h, applying the physical law of conservation of momentum to the impact, the optimum mass of the PMD is between 36 kg and 54 kg. However, the risk of back injury increases significantly with objects above the range of 16-20 kg so two weight-based categories were considered for evaluation (Table 1).

Table 1: Criteria for PMD Selection

Weight	maximum 16 kg for in between commuting trips or trips requiring lifting and carrying the device
	maximum 36 kg for devices used for all-purpose short distance trips which do not require lifting the device
Width	Maximum 740 mm
Speed Limit	Able to be speed or power limited to 10 km/h on level ground
	Maximum 25 km/h
Good manoeuvrability of the PMD	
Advanced technological features for a controlled, intuitive and safe riding experience for the rider and other users of shared facilities	

Based on these criteria and evaluation of different devices available on the market, the following PMDs were recommended for trialing in Phase 1 of the project: gyro-stabilised electric unicycles (model Solowheel); two-wheel motorised devices (model Egret One); gyro-stabilised electric three-wheel cycles (model Qugo). Each are depicted in Figure 2 below. The particular models chosen were those that were in commercial (not prototype) production and available to be imported to Australia. It is important to note that commercial prices were paid for each device and the research was not sponsored by the suppliers or manufacturers of devices.

ITEM 10 (continued) **ATTACHMENT 1**

Egret One Qugo Solowheel

Figure 2: PMDs selected for the Trial

Infrastructure Assessment

An assessment of the path infrastructure of the Macquarie University campus was made by staff from both the university and the City of Ryde. This assessment found that the campus infrastructure was adequate for the trial subject to the following conditions:

(a) Remedial action that needed to be undertaken, principally marking of areas of hazard,

(b) Areas to be excluded from the trial because of inaccessibility via pedestrian routes, as shown in Figure 3.

Development of Education Packages

Training on devices was deemed necessary in principle and also to satisfy insurance and other risk-related requirements. Education packages were developed and approved, and are discussed in more detail from page 28.

ITEM 10 (continued) **ATTACHMENT 1**

Figure 3: Map of Campus with Trial Exclusions

Research Review and Research Design

As found in the project literature review, there is considerable research on the use, injuries and accidents relating to the Segway personal transporter. However, the weight, size and anticipated journey distances of Segways did not meet the definition of PMD in this research project (see selection criteria; Table 1). Moreover, there is very limited research on trialling PMDs or personal transporters in real world settings. This project built on three separate research trials conducted in Canada, Germany and the United States (Darmochwal 2006). Essentially, the objective was to evaluate the usability and performance of PMDs in a naturalistic setting. The timeframe and expertise of the research team meant that detailed evaluation of the technical performance of the PMDs was not viable. Instead, the focus was to be on their use in a semi-controlled environment. The controlled elements are the bounded environment, the distinctive characteristics of its population, and narrowly defined trip purposes – trips conducted in the course of working on a large university campus. It was semi-controlled because where, how often and how far each rider travelled on a PMD was determined by the rider, not the research team.

Review of other trials and desired research outcomes were triangulated with the resources, expertise and time available. The outcome was a proposed trial of 12 weeks' duration, on the Macquarie University campus, in which university employees would use three PMDs each for one week. Data on the trips, speed, rider experiences and interactions with pedestrians were to be collected through a number of methods, including GPS tracking, video of campus, questionnaires and interviews. This research design was approved by the steering committee and was the basis of a successful research funding application to Macquarie University. Changes were made as the trial proceeded, as explained below.

Approvals Required for the Trial

The following approvals were required in order for the trial to proceed.

Import approval from the Commonwealth Government

Because the PMDs used in the trial do not meet Australian standards for vehicles, approval was required to import them into Australia, and was given by the Federal government. While available for inspection and customs formalities, these documents were in practice not requested during the process of importing the Solowheels, which arrived at the university via ordinary mail/parcel delivery. The relative ease of importation was confirmed when, just prior to the trial commencing, a member of the project team sighted a Solowheel (not part of the trial) being ridden across campus.

Ministerial Order

Use of the devices was permitted via a ministerial order issued by the NSW Minister for Roads. The order identified six PMDs by serial number, and specifically exempted the trial participants riding these devices from:

The following provisions of the road transport legislation, subject to the conditions contained in clause 7 of this Order:

1. The Road Transport (Vehicle Registration) Regulations 2007; and

2. Section 25 of the Road Transport (Driver Licensing) Act 1998; and

3. Rules 248, 288 (1), 289 and 290 of the Road Rules 2008.

The conditions for this Order were that the Trial Participant while a Rider of a Personal Mobility Device:

1. Wears a bicycle helmet that complies with the joint Australian and New Zealand standard AS/NZS 2063 Bicycle helmets while riding the Personal Mobility Device.

2. Rides the Personal Mobility Device to the left of any path (except when overtaking) and gives way to all pedestrians on the path, including pedestrians riding wheeled recreation devices.

3. Does not ride on any road or any shoulder of a road except for the purposes of crossing the road.

4. Does not carry any passengers or animals on the Personal Mobility Device.

5. Does not ride the Personal Mobility Device during a Period of Darkness unless the Personal Mobility Device, or the rider, displays:

(a) a flashing or steady white light that is clearly visible for at least 200 metres from the front of the Personal Mobility Device, and

(b) a flashing or steady red light that is clearly visible for at least 200 metres from the rear of the Personal Mobility Device, and

6. Does not exceed 10km/h on the Personal Mobility Device.

7. Does not ride the Personal Mobility Device without a bell, horn, or similar warning device that is in working order and that is fitted to either the Personal Mobility Device or is carried by the Trial Participant.

8. Carries a Trial Participant Identification Card at all times while riding the Personal Mobility Device and produces it when required by a law enforcement officer.

An amended Ministerial Order was granted later to allow a replacement Qugo to be included in the trial.

Macquarie University

Permission was granted from Macquarie University to use the campus for the purposes of the trial and make reasonable physical modifications (path markings, use of mobile cameras), and from the university's security service to add surveillance cameras. More importantly, negotiations with Macquarie University were required in order that appropriate insurance was obtained to cover both research participants ('riders') and other campus users in the event of an accident. The former were covered by Work Health and Safety insurance as the riders were employees using the device in the usual course of their employment. For this, a risk assessment was undertaken and appropriate risk mitigation measures made. These included training, provision of information and other elements of the usage protocols described below. Other campus users were insured via the university's general liability cover, with the PMD trial specifically noted on this insurance policy.

Approval to conduct the research as complying with the National Statement on the Ethical Conduct of Research was applied for and granted. There were two stages to the ethics application. The first application was to conduct the trial, including the use of staff, training and their monitoring via GPS, with approval gained in February 2013. From a research ethics perspective, the key issues were to ensure the informed consent of participants and their safety. No significant modifications to research design were required at this stage. The second ethics application ensued from steering group discussions about how to best capture PMD-pedestrian interactions in the trial given the unavailability of appropriate camera technology for individual PMDs. Thus this application requested the use of surveillance cameras at different parts of campus (see below) to monitor pedestrian-PMD interactions, and a survey of pedestrians on campus. This raised a number of additional ethical concerns, around gaining the consent of those (i.e. pedestrians) not participating in the trial, as well as dealing with the consequences of (inadvertently) filming illegal behaviour. Camera clarity was reduced so that the likelihood of individuals being identified in the video footage was minimal. In addition, gaining consent was dealt with by placing large signs around the camera locations and giving pedestrians the opportunity to ask for video footage of them to be deleted if they wished (see Figure 4 below). One pedestrian's request was made and acceded to. Legal advice was obtained about inadvertent filming illegal behaviour. No incidents of such a nature arose during the trial.

Figure 4: Sign Warning of Surveillance Camera

ITEM 10 (continued) **ATTACHMENT 1**

The Trial

A site trial of PMD use was conducted. Three different types of PMDs were selected, based on criteria developed by the trial team – the Solowheel, Egret One and Qugo. A pilot trial using research team members as participants occurred during the week of 15 April 2013. In this week, the team tested protocols, data collection mechanisms, interview schedules and training packages. The trial began on 22 April 2013 and proceeded for the next nine weeks, ending on 21 June 2013. Riders used the PMD during their work day, travelling on shared paths. Devices were speed limited to a maximum speed of 10km/h.

Trial Modifications

As occurs with all research projects, a number of unexpected difficulties were encountered that forced changes to the original research design. Minor changes are not documented in detail here. Key modifications are outlined, categorised in terms of pre-trial and during trial.

In the preparatory pre-trial phase, significant delays were experienced because of the complexity of the regulatory approvals. These had the effect of shortening the available time in which to trial the PMDs, since an end date of 30 June was fixed due to budgetary and personnel commitments. Difficulties were also experienced in finding a technological solution that would both track device use and take video footage simultaneously within the budget and time constraints of the project. It was deemed preferable for both functions to be achieved by one device as that would minimise inconvenience to the riders. However, from many devices tested no one offered the required technological performance within the budget and time available for the trial. Consequently, a commercial solution that tracked use without video was selected. This meant that the placement of additional surveillance cameras on campus was required, and the additional ethics application as described above.

Two significant changes occurred during the trial itself.

First, during the testing phase, the Solowheel device proved extremely difficult to master and it was decided to take the device out of the main trial. It was instead offered to fitter and more agile riders, together with dedicated and longer training over two days. As expected, it proved difficult to find volunteers for the Solowheel. Only five volunteers tried it and three used it in a separate trial. Results for the Solowheel are reported where relevant below, but are not included in the overall figures because of the different trial conditions.

Second, one of the original Qugos broke down after the GPS unit was fitted, and delays ensued as first spare parts, then a new device, were imported. This had two key outcomes. For the first six weeks of the trial, only three devices (two Egrets and one Qugo) were used, thus limiting the total number of riders. The unavailability of one device also meant that fewer riders used more than one device.

ITEM 10 (continued) **ATTACHMENT 1**

Communicating with Campus Users

Given the novelty of PMDs in the campus environment, a campaign to inform campus users of the presence of PMDs on campus was undertaken in the week preceding and the first weeks of the trial. This included circulation of information and posters to all University tenants (e.g. Cochlear) and personal approaches to childcare centres on campus, as well as articles about the trial in university news outlets, university-wide staff email and student web site announcements and print and electronic notices across campus. A special PMD university Wiki site was also made available to all staff and students to make comments, as well as a dedicated email (pmd@mq.edu.au) and phone number. Campus users were informed of cameras by highly visible posters throughout the trial period (Figure 4 above).

Selection and Recruitment of Personal Mobility Device Riders

To meet the project objectives, a broad sample of riders was recruited. The PMD riders were able to travel anywhere around the campus, with the exception of one open-air carpark (known as E10) identified in Figure 3 above, to ensure sufficient interaction with other shared-path users and under various weather conditions.

Riders were recruited from among the staff at Macquarie University. Participants were recruited via advertisements and other media coverage of the trial. They contacted the project research team, where final selection was based on a few criteria aimed at obtaining participants who usually travelled across the campus each day during their work-related activities.

In all, 17 riders (nine men and eight women) were recruited, trained, then rode a PMD for one week in pedestrian zones, namely footpaths. After one week, most participants were trained on another device and trialled that one for a week. With adjustments to the original research design, the resultant mixture of riders and devices is summarised in the Table 2 below.

ITEM 10 (continued) **ATTACHMENT 1**

Table 2: Riders, Devices and Timetable of the Trial

Trial wk		Egret 1	Egret 2	Qugo 1	Qugo 2	S'wheel	S'wheel 2
wk1	22.04-27.04	P1	P2				
wk2	29.04-3.05	P3	P4	P2		P5	P6
wk3	6.05-10.05	P7	P8*	P9		P5	P6
wk4	13.05-17.05	P8*		P7			P3
wk5	20.05-24.05	P5	P10 and P11	P12			P3
wk6	27.05-31.05	P6	P13	P10 and P11			P3
wk7	3.06-7.06	P14	P15	P13	P3		
wk8	10.06-14.06	P17	P16	P15	P14		
wk9	17.06-21.06			P5	P17		
		* device broke down wk 4					
		One device	6				
		Two devices	9				
		Three devices	2				

Usage Protocols

Riders of PMDs were subject to strict usage protocols to ensure their own safety and the safety of others. The protocols were:

- Individual research participants were required to give free, prior and informed consent to their participation,
- Individual research participants would undergo appropriate training in both use of the PMDs in the trial and the safety and the research protocols governing the trial,
- Individual riders' use of PMDs would be tracked electronically and by video recording to monitor adherence to the geographical boundaries of the trial, with non-compliance resulting in exclusion of an offending rider from future participation in the trial,
- Individual riders of PMDs in the trial would operate the selected devices for trial purposes only, with non-compliance resulting in exclusion of an offending rider from future participation in the trial,
- All the devices supplied were limited to a maximum speed of 10km/h on level ground,
- All riders were to keep to the left of the path, except when overtaking, and give way to all pedestrians, including pedestrians riding wheeled recreational devices,
- The devices were not to be used at night,
- No passengers, including animals, were to be carried on any device during the trial,
- The devices would not be used to tow, or not be towed by, another vehicle,
- The devices were not to be ridden on a dividing strip or median strip,
- The riders of the devices would comply with the Australian Road Rules part 14 (Rules for pedestrians) as if the rider were a pedestrian,
- Participants in the trial would report any incidents using the incident reporting protocol.

Riders were informed of these protocols in the training sessions before their first use of the devices (induction sessions). An incident reporting protocol was included within the research trial protocols.

To summarise:

PMD riders:

- Were trained in the use of each device,
- Wore helmets,
- Were confined to the Macquarie University campus,
- Carried a card identifying them as participants in the trial.

Devices:

- Were speed limited to 10km/h, measured on level ground with a 80 kg loading mass,
- Had bells/horns affixed to warn pedestrians of their approach,
- Had lights affixed for use when light was poor (the conduct of the trial in winter made this imperative),
- Had GPS tracking units attached.

Data Collection and Analysis

Data were collected using a mixture of methods appropriate to different elements of the project, as follows.

Rider Experiences of the PMDs

Pre-, mid- and post-trial questionnaires were administered to gain subjective reflections of participants' experiences of riding different PMDs (see Appendix 1). Questions covered the more technical aspects of device use like balance, but also perceptions of ease of use, weight and storage. Answers were coded and simple descriptive statistics calculated.

Wiki posts on their experiences. Riders were encouraged to write about their experiences on a Wiki site open only to university staff and students. All riders made some blog posts, with some being more active than others. Only two non-trial staff commented on the blog even though it was open for comment to all staff and students on campus. At the end of the trial these blog posts were collated and thematically coded in terms of: pedestrian interactions, safety, fun, attracting attention, hills and stairs, infrastructure, incidents, lack of power, secure parking, technical issues, time saved and the weight of devices. A sample of comments is provided in Appendix 3.

Device Usage

GPS units were affixed to each device and tracked the speed of trips, distance and location. In the pre-trial phase considerable experimentation with forms of tracking

ITEM 10 (continued) **ATTACHMENT 1**

units (e.g. a custom-developed App) occurred. However, none of these solutions proved viable, especially in terms of minimising the amount of recharging or turning on/off required by riders. Thus a solution was chosen that entailed connecting a GPS tracking unit to the PMD's battery which turned on and off by the same switch or key of the PMD.

Specifically, each PMD was equipped with the Myionu Portable Unit (technical specifications are available on request). The units required a power feed with a voltage range of 8~32v, as well as a mechanism to trigger a trip start and stop record. Normally this is in the form of an on/off switch which also needs to be within the 8~32v range. Design and technical issues meant that the GPS unit was connected to each device in different ways, as follows.

The Egret One had the GPS units connected to the on/off switch generating an electric impulse to the GPS tracker every time the PMD was turned on or off. In other words, the Start Trip was triggered by the Ignition On event and the End Trip by an Ignition Off event. If the GPS tracker did not report in for more than 300 seconds, the PMD was considered parked and the trip ended, regardless of the Ignition Off signal.

Wiring the GPS tracker to the three-wheel PMD (Qugo) proved to be a difficult operation. After the failure of one Qugo during the installation, the GPS tracker was attached to the PMD's frame, without any connection to the battery or to the key's switch. For the Qugo then, a Trip Start was triggered by motion, and Trip End was defined as stopped for more than 300 seconds. Stop was defined as no motion for 120 seconds and speed less than one kilometre per hour.

The GPS tracker could not be installed and connected to the on/off switch of the Solowheel because of its small physical size and different voltage range. Instead, and similarly to Qugo, the GPS tracker was attached with Velcro to the PMD's frame.

Detailed reports through the online Myionu Portal supplied the start date, time and location and each update the unit made including speed, location and distance travelled. Data were updated at intervals of one minute. Camera locations were entered into the software. In this way, we knew every time a PMD was within the camera's coverage area. Automated alerts were configured to send emails with the speed, location, PMD ID and rider ID making the location and selection of video images easier. Similarly, alerts were configured to send emails when a participant crossed the boundaries, entered into the No-Go zone or recorded excessive speed.

Pedestrian Interaction

Interactions between PMDs and pedestrians, as well as perceptions of each, were gathered in three ways.

A *Pedestrian questionnaire* (Appendix 2) was administered. It comprised 19 items that captured quantitative and qualitative data, including demographic information of

ITEM 10 (continued) **ATTACHMENT 1**

age and gender, plus information on pedestrian interactions with, and perceptions of PMDs. Surveys were administered in face-to-face, street-intercept interviews, on the Macquarie University campus. Surveys were conducted on different days of the week at different times of the day and different locations within the campus. Survey respondents were selected from the sample frame by systematic random sampling, using a sampling interval of five, resulting in a sample size of 200.

Fixed surveillance cameras were hired to monitor key parts of the campus. The fixed cameras were located at two sites of high pedestrian activity. A mobile camera was also used at two different sites – first outside the Library and second on Wally's Walk, the main pedestrian thoroughfare. All three positions also had to take account of trees blocking the camera's view, which was especially apparent along Wally's Walk. When a PMD passed in the vicinity of a camera an alert was sent to the PMD email address, logging time, place and device.

Data related to PMD events captured on the CCTV cameras were extracted from the footage using the time and date stamping. One hundred and thirty video events were extracted and analysed. The majority of the video clips (51%) were located at the Central Hub, a large open space with a ramp that facilitates travel to many other parts of campus. The next most frequent location was Eastern Road (32%), which included the most frequented road crossing. Then followed Wally's Walk (14.5%), a long straight and wide thoroughfare that serves as the main non-vehicular east-west spine for pedestrian movement on the campus. The remaining video clips were located at the Library (2.5%) which like the Central Hub is also an open space but with roads on two sides of the perimeter. Though the Library is a pedestrian-dense location, few PMDs used that space.

Video events were analysed using a coding scheme designed to capture pedestrian interactions with PMDs, identify PMD riders' level of compliance and observe the riders' experiences to complement the questionnaires.
Each clip was numerically coded for:

- Time and date,
- Location – to identify any differences in interactions/compliance by location,
- Device type - to identify any differences in interactions/compliance by PMD type,
- Compliance,
    - whether PMD riders were wearing a helmet,
    - whether PMD riders were speeding (above 10km/h),
    - whether PMD riders disembarked to cross roads,
- Number of pedestrians present that either interacted or were in close enough proximity to a PMD to potentially interact with the PMD,
- Number of vehicles present including motor vehicles, bicycles and skateboards,
- Whether the PMD rider or pedestrians had to move out of the way,

- Whether pedestrians were using technologies such as mobile phones or music through headphones that could distract them,
- Whether any incidents were captured.

Each of the 130 clips underwent analysis based on the above coding scheme. After the initial analysis, a second analysis based on the same coding was conducted by a second person to verify initial analysis results and maintain reliability, validity and accuracy. A summary of descriptive measures such as frequency counts was produced from the data contained in all 130 cases.

Summary of Trial Parameters

In sum, this was a controlled trial with a limited number of devices and users, designed as a pilot for further research. It aimed to examine rider experiences, as well as pedestrian interactions, and to provide some insight into policy and regulatory use within the wider transport system.

Pressure on time frames and mechanical issues forced changes to the planned (and ideal) research subject. As a result, two PMDs were subject to the same research protocol (two-wheeled and three-wheeled) while the one-wheeled PMD was subject to a separate protocol with fewer but more able riders.

Trial Evaluation (1): Induction and Training

For this project, all participants took part in a training session that was tailored for each device.

Training of Personal Mobility Device Riders

Theoretical training

Riders received about 20 minutes of theoretical training at the beginning of the session. Participants were instructed on the operation of the device (performance, acceleration, braking), how their PMD should be ridden, how to charge it, fold it (if required), the location of the bell or horn, lights and the duress button. Participants were also instructed on how to secure the device when not in use, and informed that the GPS device would continuously record their trips and speed. Participants were also briefed on pedestrian safety rules, rider etiquette in sharing footpaths with other users, and the project-specific rules under which the device could be used such as: the authorised perimeter of the trial area, and the conditions of the Ministerial Order governing the use of PMDs, including that of helmet wear. This information was also contained in full in the participants' training manual with illustrations from each of the manufacturer's rider manuals and served to make the training as safe as possible and consistent with the manufacturers' recommendations for use of the devices. The trainer paraphrased or expanded on instructions where necessary. For example, those trialling a second device, were reminded of the conditions under which the trial was being conducted, and thereafter the focus of the training was on the operating instructions of the new device.

Theoretical training also included instructions on the use of accessories, in particular the bell/horn, lights and duress button on the Qugo (Figure 5). Explanations were provided to riders who received accessories with their PMD so that they would use them correctly during their week's trial. Participants were advised not to hang bags on the handlebars and that a backpack could alter their centre of gravity and affect their balance.

ITEM 10 (continued) **ATTACHMENT 1**

Figure 5: Duress button on Qugo

Figure 6: Rider receiving instruction on the use of the Qugo controls

Practical training

The second phase of training took about one hour, and consisted of a practical session to acquaint riders with the operation of the PMD under various conditions. By means of practical exercises, such as navigating a slalom course and steering around

ITEM 10 (continued) **ATTACHMENT 1**

pedestrians, riders developed the appropriate skills when encountering obstacles. They also became aware of the limitations of the devices, particularly when traversing uneven surfaces and inclines.

Training was conducted on an outdoor basketball court, with a synthetic turf surface at Macquarie University (Kompan 1):

• The basketball court was 15.24 metres wide and 28.65 metres long,

• A slalom course was laid out using coloured football training cones,

• Members of the research team also walked the slalom course mimicking the behaviour of pedestrians,

• When the basic navigation skills were mastered, participants were assessed riding along the nearby footpath that had a substantial incline.

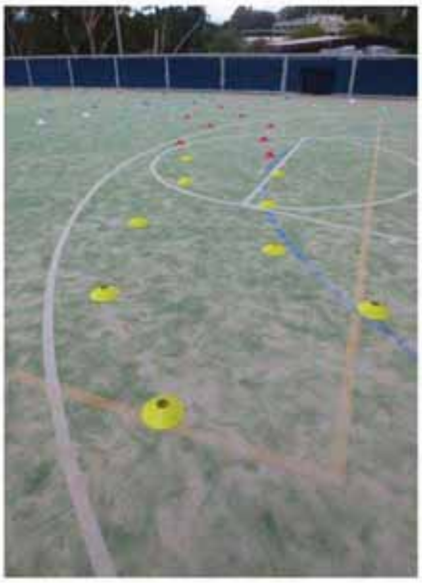

Figure 7: Slalom Course laid out with training cones

Evaluation

Rider Feedback

All participants who received the training felt ready to ride their device at the end of the practical training session. Not surprisingly however, they noted that their skill with the devices continued to grow after the practical training session, with all the Egret riders agreeing that it became easier with practise, as did 75% of the Qugo riders and 89% of the Solowheel participants.

ITEM 10 (continued) **ATTACHMENT 1**

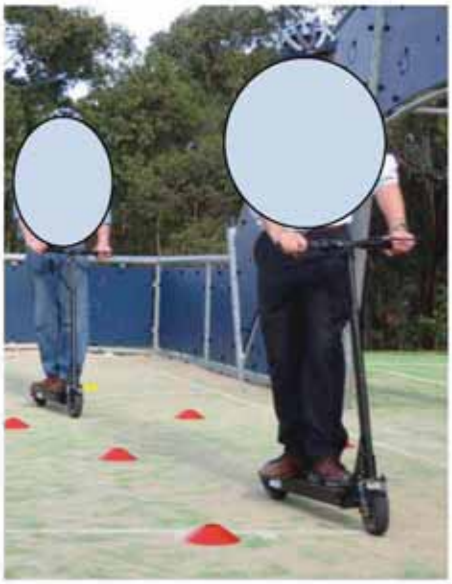

Figure 8: Participants practising navigation skills on the slalom course

Figure 9: A participant recognising the limitations of a device on an incline

Observing CCTV footage

Riders observed the rules and regulations under which they were instructed to ride. The only deviation in compliance observed was the failure of riders to disembark to cross a road that has the appearance of pedestrian priority. This was observed with both Qugo and Egret riders, which suggests that it was an inconvenient interruption to their journey in the absence of road users.

Incident

One incident occurred during the training phase of the study. A person riding a Qugo struck an object and the device began to topple and fell with the rider. The rider sustained an injury requiring hospitalisation. The person did not continue as a trial participant.

ITEM 10 (continued) **ATTACHMENT 1**

Trial Evaluation (2): Operating Conditions

This section provides an assessment of operational characteristics of the selected PMDs in the trial. It is not a performance-based specification. The assessment is a subjective one based on riders' evaluations of the devices. It presents information on actual usage (speed, distance travelled and number of trips) and a subjective evaluation of manoeuvrability. The evaluation of the PMDs' technical performance is based on criteria such as understanding the device and portability used questionnaires for each trial participant. Actual usage was calculated using the data recorded by the GPS tracking units installed on each PMD.

Overview of the Selected PMDs

Table 3 below presents a brief description of their technical characteristics.

Table 3 Technical Characteristics of PMDs in the Trial

Specification	Gyroscopic balanced unicycle	2-wheel electric powered devices (Foldable)	3-wheel gyro-stabilised electric cycle
	Solowheel	**Egret**	**Qugo**
Designed Maximum Speed (km/h)	16 km/h	6/ 12/ 20/ 35 km/h	25 km/h
Motor Output (W)	1000 W	250 W	1000 W
Weight (with battery)	12 kg	15 kg	33 kg
Maximum load (kg)	113 kg	100 kg	120 kg
Width (mm)	356 mm	560 mm	580 mm
Brake System	motor+regen	Motor-brake	3 disc brakes
Foldable version	pedals fold	Yes	handle bar only

ITEM 10 (continued) **ATTACHMENT 1**

Explanation of Speed Limiting

All devices were required to be speed limited to 10 km/h. The Solowheel and Qugo were limited to 10km/h by the manufacturer, on request. The speed of the Solowheel was lowered by the manufacturer through software programming. The speed of the Qugo was programmed to 10 km/h by the motor's supplier. The speed of the Egret was lowered by configuring a parallel circuit from the default 12km/h mode and a small adjustment to the throttle control. This speed limitation was done locally by an engineering company with further changes carried out at the RMS Crash Lab to meet the 10km/h target.

Preliminary tests of the maximum speed were conducted at the RMS Crash Lab on a level concrete surface with a run up of about 25 metres to achieve top speed. The maximum speed was determined as an average of 5-8 runs with an 80 kg person riding through the certified light gate. Both Qugos complied with the speed limit requirement. More work had to be done on site for Egrets to reduce the maximum speed to 10 km/h. The higher level of skill required to ride the Solowheel unassisted by training wheels meant that Solowheel tests were conducted with the training wheels attached to the device. The maximum speed recorded was 13.28 km/h. On checking with the manufacturer, the manufacturer guaranteed that the speed was software limited to 10 km/h through software programming and that they had tested the speed several times. They recommended testing without training wheels and while the rider is completely vertical. In that situation, according to manufacturer specifications, the Solowheel would push back to let the rider know that the top speed had been reached. Given the lack of willing volunteers to test the Solowheel without training wheels at the Crash Lab, tests without training wheels could not be conducted. However, riders in the trial confirmed that the Solowheel pushed them back when the top speed was reached.

PMD Usage during the Trial

Table 4 below presents an overview of PMD usage during the trial. In this section we focus on use in terms of total distance travelled[1], speed, and assessments of the manoeuvrability of the devices. Subsequent sections focus in more detail on usability of the devices and pedestrian interactions.

[1] Trip distance has been calculated as the distance travelled in continuous increments of minimum 100 metres based on the GPS frames with a frequency of one minute. It does not include trips less than 100m or inside buildings, nor trips during training and induction. A day of use is defined as a day when at least one trip of more than 100 metres has been recorded.

ITEM 10 (continued) **ATTACHMENT 1**

Table 4: PMD Use over the Trial Period

	Egret	Qugo
Total Distance	113.7 km	78.3 km
Days of use	47	37
Trips	132	94
Distance travelled per day	2.419 km	2.116 km
Number of trips per day	2.81	2.54
Average distance per trip	0.861 km	0.833 km
Trips < 500m	15.90%	23.40%
500m-1000m	59.80%	46.80%
>1000m	24.20%	29.70%
Average speed per trip	6.42 km/h	5.33 km/h
Speed > 5 km/h	80%	63%
Higher range 7km/h -10 km/h	37%	10%

Distance Travelled

The total distance travelled during the trial was 113.7 km on both Egrets over 47 days of use and by 15 participants. Distance travelled on the Qugo was 78.3 km over only 37 days of use and with 12 participants. The actual usage of PMDs varied from participant to participant, ranging from 1.5 km to 30 km in one week. The average distance travelled in each day of use was more than two kilometres for both devices, with the majority of trips covering distances between 500 metres and 1000 metres. The average trip distance was between 500m and 1 kilometre for 60% of all trips on Egret (79 trips) and more than 1 kilometre for 24% (32 trips) (as detailed in Table 4). The average distance per trip for Qugo riders was 0.833 km, similar to the Egret. However, the distribution of trip range is quite different to the Egrets with 47% of all trips between 500 m - 1 km and 30% of trips being longer than 1 km. Further analysis is required to differentiate whether this is due to the devices or to rider characteristics, as well as take into account the effects of weather.

ITEM 10 (continued) **ATTACHMENT 1**

Table 5: Distance travelled on Egrets by Individual Participants

Participant	Distance (km)	Days of use	Average distance per day	Trips	No of trips per day	Average distance per trip
P1	4.4	2	2.200	4	2.00	1.100
P2	17.2	4	4.300	18	4.50	0.956
P3	3.1	3	1.033	5	1.67	0.620
P4	2.5	2	1.250	4	2.00	0.625
P5	5	3	1.667	8	2.67	0.625
P6	4.9	3	1.633	5	1.67	0.980
P7	8.1	5	1.620	15	3.00	0.540
P8	3.9	2	1.950	4	2.00	0.975
P10	3.1	3	1.033	5	1.67	0.620
P11	6.5	3	2.167	10	3.33	0.650
P13	4.2	3	1.400	7	2.33	0.600
P14	7.5	3	2.500	10	3.33	0.750
P15	5.1	3	1.700	5	1.67	1.020
P16	7.7	3	2.567	5	1.67	1.540
P17	30.5	5	6.100	27	5.40	1.130
Total	113.7	47	2.419	132	2.81	0.861

ITEM 10 (continued) **ATTACHMENT 1**

Table 6: Distance Travelled on Qugos by Individual Participants

Participant	Distance (km)	Days of use	Average distance per day	Trips	No of trips per day	Average distance per trip
P2	22.1	5	4.420	24	4.80	0.921
P3	3.1	3	1.033	7	2.33	0.443
P5	3.2	5	0.640	7	1.40	0.457
P9	2.5	2	1.250	3	1.50	0.833
P10	1.9	3	0.633	4	1.33	0.475
P11	1.5	1	1.500	2	2.00	0.750
P12	15.9	5	3.180	13	2.60	1.223
P13	4.5	3	1.500	7	2.33	0.643
P14	9.4	4	2.350	8	2.00	1.175
P15	2.6	3	0.867	5	1.67	0.520
P17	11.6	3	3.867	14	4.67	0.829
TOTAL	78.3	37	2.116	94	2.54	0.833

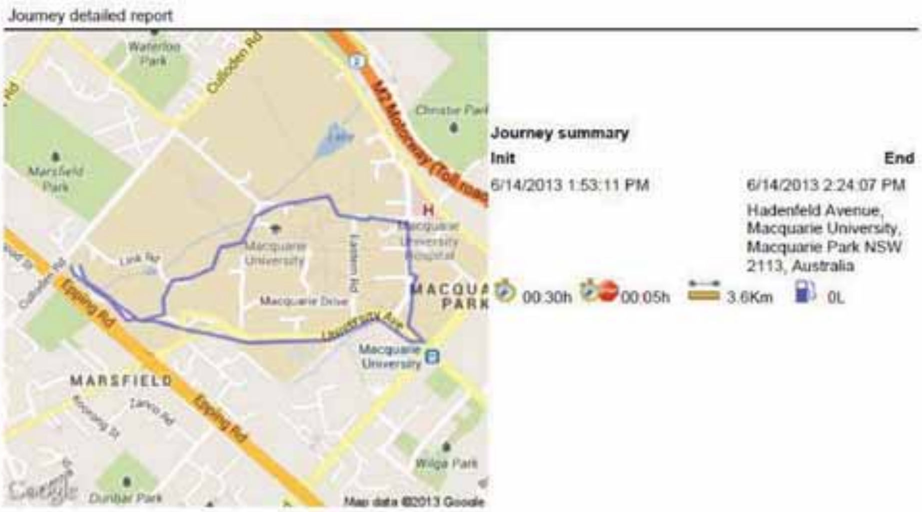

Figure 10: Map of Longest Recorded Trip

The longest recorded trip on both devices was the same: 3.6 kilometres taken by two riders travelling together (one on a Qugo, the other on an Egret) shown in Figure 10.

ITEM 10 (continued) **ATTACHMENT 1**

Interestingly, the average speed of the trip on the Egret was 6.54 km/h while the same trip on the Qugo recorded a value of 5.95 km/h.

Speed

All devices were required to be speed limited to 10 km/h. All three manufacturers cautioned that the means of speed limitation would impact the power and the overall performance of the device. The method of speed limitation also meant that it was possible for devices to reach higher speeds downhill. In this case, the Egret motor cut the power at 10 km/h speed limit so the devices were propelled by human power only.

Average speeds across all riders were 6.4 km/h for the Egret and 5.3 km/h for the Qugo (Table 4 above). Both are only marginally more than pedestrians' pace. Given the diversity of riders, it is also useful to consider the range of average speeds (Figure 11 below). For 80% of Egret trips the average speed was higher than a fast walking pace of 5 km/h, compared to 63% of Qugo trips. The majority of trips on both Egret and Qugo were in the range of a fast walk (5 km/h) and easy jogging (7 km/h).

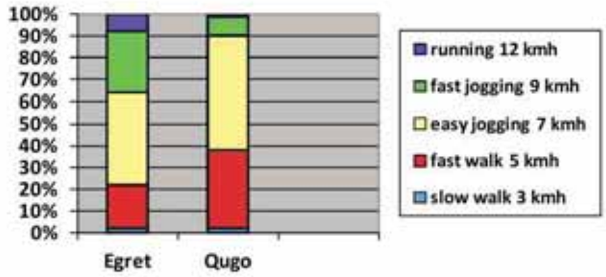

Figure 11: Average Speed Distribution for Egret and Qugo Riders

The average trip speed was higher than the fast walking speed of 5 km/h for 80% of Egret riders with a maximum average speed recorded of 10.83 km/h. From the total of 132 trips recorded on Egrets, 37% of trips were recorded at the higher end of the speed range (7 km/h – 10 km/h).

ITEM 10 (continued) **ATTACHMENT 1**

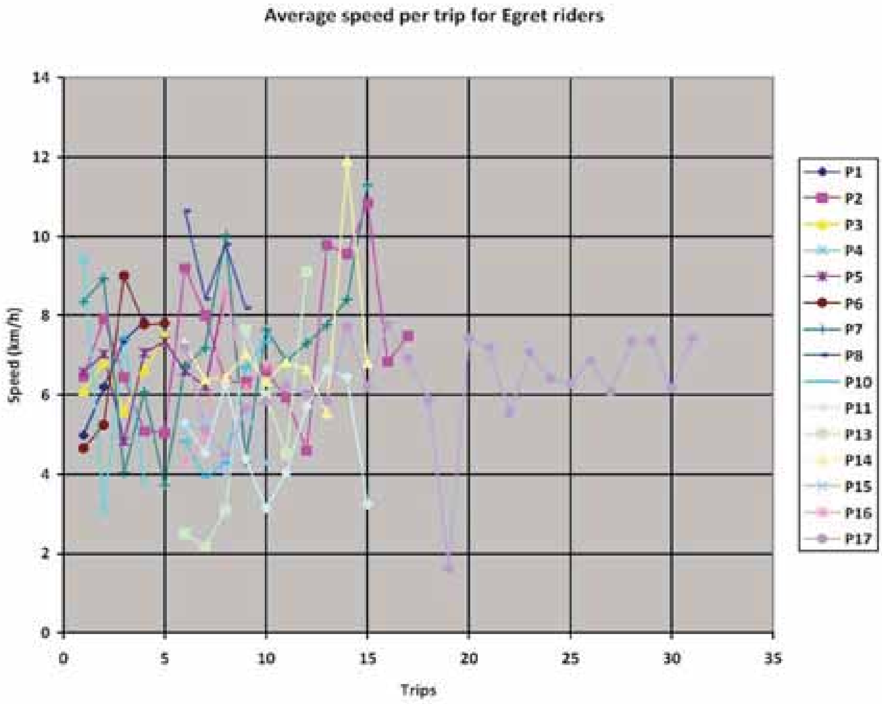

Figure 12: Average Speed per Trip for Egret Riders

For trips on Qugos, the average trip speed was higher than the walking speed of 5 km/h for 63% of all trips, with a maximum average speed recorded of 10.35 km/h (Table 4). The absolute maximum value of speed recorded was 19.9 km/h on Wally's Walk. However, from the total of 94 trips recorded on Qugos, only 10% of trips were recorded at the higher end of speed range (7 km/h – 10 km/h) compared to 37% of trips on Egrets.

ITEM 10 (continued) **ATTACHMENT 1**

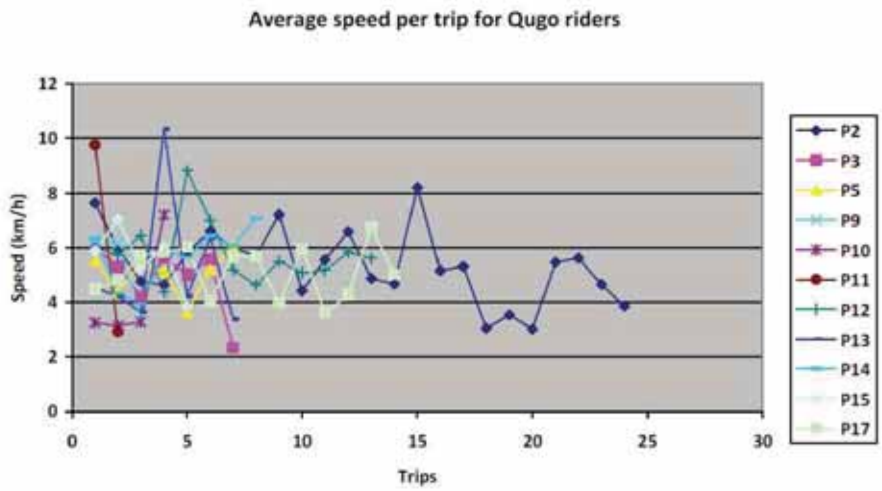

Figure 13: Average Speed per Trip for Qugo Riders

Manoeuvrability

No objective measure of device manoeuvrability was gained from this research. Subjective measures are available from the rider questionnaire, with results in Table 7 below. Difficulties balancing while riding the Egret were not a common occurrence for any riders, and more than half never had difficulty balancing. A very similar pattern holds for steering the Egret. In comparison, balance and/or steering difficulties were significant (as measured by the 'often' response) for between one-fifth and one-quarter of Qugo riders, though 40% reported no difficulties. The Solowheel results are intriguing here, reporting fewer difficulties with both balance and steering than Qugo riders. Again this may be due to self selection and the very small sample size.

Table 7: Riders' Experiences of Balance and Steering Difficulties with PMDs

	Egret (%)	Qugo (%)	Solowheel (%)
Balance – often	0	25	11.1
Balance – occasionally	46.7	33.3	40.7
Balance – never	53.3	41.7	48.2
Steering – often	0	16.7	7.4
Steering - occasionally	53.3	25.0	40.7
Steering - never	46.7	48.3	51.9

ITEM 10 (continued) **ATTACHMENT 1**

Care, Maintenance and Service

During the pre-trial period, all three models were fully assembled, had their batteries charged, tyre pressure checked and corrected to the required parameters. All devices were tested for compliance with manufacturer specification and the speed limitation requirement. The following maintenance issues were experienced.

Qugo

When carrying out the installation of the GPS tracker, one Qugo broke down. Given the lack of any Qugo service centre in Australia, it was impossible to diagnose what circuitries had been damaged although the manufacturer offered technical assistance to sort out this matter. A full set of PCBs were ordered from the Netherlands, however the Qugo failed for a second time, leading to the conclusion that the motor could have been damaged by the first GPS tracker wiring operation. Modifications to the Qugo could have impacted on performance and speed limitation, breaching the conditions for the import and testing as approved by the Minister for Roads and Ports. Moreover, importing new spare parts, including the motor would have taken longer than to import a new Qugo, and the lack of local expertise meant that the new parts may still not provide an adequate solution. Instead, variations to the Import Approval and the Ministerial Order were requested and granted to use a new Qugo as a replacement for the broken one.

During the last week of the trial, a participant reported that both front and rear wheels of the Qugo locked after the rider applied both brakes to stop it before a ramp. The rider applied the brakes and released them slowly a couple of times with no improvement to the situation. The Qugo started to move freely again after shutting down for a while. The participant decided to continue using the Qugo for the week. When contacted, the manufacturer suggested that the problem could have been generated either by overheating of the motor while riding uphill or if the brake callipers were unable to move freely due to dirt, brake cable jamming, or the like.

Another problem with the same device occurred a day later when the participant jumped off it and the Qugo fell on the footpath. The brake lever for the front wheel was broken and the Qugo was removed from trial.

Egret

In week three of the trial one of the participants reported issues with the battery of an Egret. Although the Egret was charged continuously at night, the battery was fully discharged. Based on inspection by a local electrician and technical assistance from the German supplier, the problem was identified as being generated by the GPS tracker connection by tapping 12V from the battery and regulating it to 5V for

ITEM 10 (continued) **ATTACHMENT 1**

the GPS. The $LIFePO_4$ batteries are known to have some balancing issues and because the GPS tracker circuit discharged some cells in the series string more than others, it damaged the battery.

In this case a new battery was provided by a local supplier of electric bike parts, as recommended by the Egret's supplier. Although no issues with the battery were reported for the second Egret, the GPS tracker was disconnected from the battery and a new separate circuit for charging the GPS was installed.

Solowheel

With the exceptions of abrasions to the device's body, no technical issues were reported for the Solowheel.

In conclusion, all three models were equipped with advanced engineering technology, yet the lack of specialised local service and expertise with this technology was problematic, limiting the availability of devices during the trial period.

Trial Evaluation (3): Pedestrian Interactions and Perceptions

Information on pedestrian-PMD interactions in shared spaces was gathered in three ways: (i) PMD riders were asked questions about pedestrian interactions and their perceptions of riding in a pedestrian environment; (ii) pedestrian-PMD interactions were filmed and analysed; and (iii) a survey of pedestrians was undertaken.

PMD Rider Experiences with Pedestrians

PMD riders were asked a number of questions about pedestrians and their interactions with pedestrians. Only two negative comments were made in the rider questionnaires, both by Egret users who regarded pedestrians as a drawback to PMD use. The majority of Egret and Qugo riders found the presence of pedestrians as a drawback only occasionally, with one-third not experiencing pedestrians as a drawback (see Table 8 below).

Table 8: Riders Experiencing Drawbacks Due to Pedestrians

	Egret (%)	Qugo (%)	All (%)*
Often	13.3	0	5.0
Occasionally	60	58.3	59.3
Never	26.7	41.7	33.3

* excluding Solowheel

Indeed, for almost all riders, interacting with others on shared paths was easy, and definitely not difficult. This was more so for Egret than Qugo riders (see Table 9 below). A certain level of frustration with sharing was evident, much more pronounced with the Qugo, presumably because of its larger size and weight.

Table 9: Riders' Perceptions of Interactions with Others

	Egret (%)	Qugo (%)	All (%)*
Easy	92.3	50	86.7
Difficult	0	0	0
Frustrating	7.7	50	13.3

* excluding Solowheel

Riders' blog comments such as those below confirm these findings:

ITEM 10 (continued) **ATTACHMENT 1**

Pedestrians seem to be reasonably comfortable with Egret around. When they hear the sound of the bell/engine, they move to one side.

I do reasonably well at weaving through pedestrians (Egret Rider).

Several comments were made in regards to the devices attracting positive attention and Qugo riders commented that pedestrians were more aware of its presence than the Egret, facilitating the ease of pedestrians moving out of the way.

There has been far more pedestrian/staff interaction with this device, but still, I've found it generally positive …The sound of it coming definitely helps with people being aware of it too (Qugo rider).

When asked to identify common problems experienced riding on campus, the most frequently identified problem was pedestrians (25 percent of problems identified). When asked to expand, problems included navigating around pedestrians when the path was crowded and pedestrians being unaware, unresponsive or distracted, as evident in the blog comments below.

Pedestrians are even more unpredictable than I expected - stopping suddenly, ignoring bells, etc (Egret Rider).

I had one pedestrian texting on the phone that walked straight into me. I had slowed in general anticipation and eventually came to an abrupt halt … it's still hard to look into the faces to read expressions while also riding and anticipating walkers (Egret Rider).

There was also one incident reported on a Qugo due to the rider's attempt to give way to pedestrians on a narrow path. The rider lost balance when applying the brakes, ran a couple of steps then fell on the road resulting in minor scrapes and bruises.

When participants were asked to consider any difficulties of using the devices off campus, pedestrians were of a lesser concern with only six out of 31 comments that pedestrians may be a problem off campus. On the blog one rider raised speed and harm to pedestrians as potential issues in using PMDs off campus. Comments typically raised concerns about pedestrians being distracted by a mobile phone or headphones, and many pedestrians being unaware of the shared access concept.

From the perspective of the PMD riders in this trial, interactions with pedestrians occurred seamlessly with a number of exceptions. Rider training emphasised that pedestrians had right-of-way, yet some level of frustration was still experienced, especially when pedestrians were thought to be behaving erratically. This is an important point that should be followed up in subsequent research.

PMD-Pedestrian Interactions

The on-campus cameras captured 130 instances of PMD use. Of these, 87% involved pedestrians. Sixty percent of events had between one and five pedestrians; and one

ITEM 10 (continued) **ATTACHMENT 1**

quarter captured a more crowded path with six or more people. The presence of other vehicles such as cars or bicycles was low at fewer than 12% of instances.

Overall there was harmony between PMD riders and pedestrians as they passed each other. The majority (79%) of the time PMDs did not have to alter their direction, slow down or break for pedestrians. Neither did pedestrians need to move out of the way (90% of the time). Even during times of significant crowding of 10-15 people in the proximity of a PMD, both the PMD and pedestrians appeared to seamlessly anticipate and navigate around each other.

The Egret and Qugo moved out of the way on average three times more frequently than the Solowheel, at 23%, 21% and 7% respectively. This does not mean, however, that pedestrians had to move very often for the Solowheel. The Solowheel and the Egret had the highest instances where pedestrians were not required to move out of the way (both 93%), presumably due to their lesser width. The instances where pedestrians had to move out of the way were highest for the Qugo (15%). This most commonly occurred at the Library (33%) followed by Central Hub (18%). In contrast no pedestrians moved out of the way at Eastern Road or Wally's Walk. On five occasions the rider was observed to disembark in order to be cautious of oncoming pedestrians.

There were no recorded incidences of PMD-pedestrian conflicts observed from the video clips. Surprise was identified in two cases. The first shows a surprised reaction from the pedestrian when encountering a PMD. The second shows an Egret with a cyclist approaching from behind, which startled the PMD rider who was walking the device and steered the device away.

Reactions from Pedestrians

A survey of pedestrians on campus was conducted over five weeks of the trial in order to gather data on pedestrian interactions with, and reactions to, PMDs. At different times of the day, and on different days of the week, every fifth pedestrian was approached, and asked if they had seen a PMD. If the answer was negative, they were thanked for their time. If the answer was positive, a survey was administered. Of the 1482 pedestrians approached, 200 (13.5%) had either observed or interacted with a PMD on Macquarie University campus. The most frequently sighted PMD was the Egret (213), followed by Solowheel (157) then Qugo (129). When it came to the general attitudes towards PMDs and their operation on campus, the majority of respondents (79.5%) were positive about the idea of PMDs.

Pedestrian Interactions

The majority of pedestrians surveyed (91%) did not have to alter their direction when sighting a PMD. Of the 9% that did have to alter their direction, only 11% said that the PMD moved around them. The majority of pedestrians (98%) encountered

ITEM 10 (continued) **ATTACHMENT 1**

no problems with PMDs; of the 2% that did, it was due to the PMD blocking the way. Regarding the noise levels of PMDs, almost three quarters of the pedestrians surveyed heard a PMD coming (73.5%). The majority of pedestrians (99%) did not think PMDs were too loud. There was more concern about them being too quiet (25%). However the number of people startled by a PMD was small (1% of all respondents).

Pedestrian attitudes to others using PMDs

The majority of pedestrians thought PMDs were suitable to operate near pedestrians (91.5%) and in enclosed spaces like the university campus. As well, most interviewees (77.5%) thought PMDs were suitable to operate on shared footpaths. In the general comments, a total of 70 further comments were made. PMDs' suitability was mostly thought to be determined by the footpath width (31.5%), followed by the rider's level of skill or responsibility (28.5%), and the crowd density (17%). Other concerns related to the size/weight of the device, its speed and the need for designated pathways, although these were minimal at fewer than 8% of the 70 comments made.

Pedestrian attitudes to using PMDs

When it came to using PMDs, slightly more than half of pedestrians surveyed (55.5%) said they would use a PMD. Out of the comments made regarding their reasons why pedestrians would not use a PMD, the most frequent reason was that they preferred to walk (28.5%), 18% thought they would be embarrassed, concerns over the level of skill needed to ride (17%), that PMDs were not practical (10.5%), or necessary (7.5%).

To an open-ended question asking pedestrians why they would use a PMD, a total of 67 reasons were given. Of these, 36% said it was because they were 'cool' and they were curious to learn more about PMDs. Approximately a third commented that it would be quicker and more convenient travel (30%) and there was some interest in how the PMDs would be made accessible financially and logistically.

Summary

The overwhelming majority of the campus population was comfortable with, and welcoming of, PMDs in a pedestrian environment. The identification of factors like 'cool' confirms the relative youth of the campus demographic. There were no reported or recorded incidents with pedestrians.

Trial Evaluation (4): Rider Experiences and Social Dimensions

Introduction and Description of Sample

Riders were recruited from within Macquarie University staff, with a preference for those who travelled across campus on a daily basis. Riders had an average age of 37 years; three quarters had full drivers' licences and 70 percent came to work as either a car passenger or driver. Interestingly, 40 percent used a bicycle on a regular basis.

Perceptions of PMDs and PMD Use

Before the trial, only a small number of riders had heard of PMDs and this was mostly in relation to mobility scooters and Segways. Ninety percent of riders found using a device very or moderately enjoyable, and the same percentage found it moderately or very comfortable to ride. There were interesting differences between the devices here, as indicated in Table 10 below. Qugos were more comfortable but less enjoyable than Egrets.

Table 10: Level of Enjoyment and Comfort Experienced

	Egret (%)	Qugo (%)	All (%)*
Very Enjoyable	53.3	33.3	44.4
Moderately Enjoyable	46.7	41.7	44.4
Not Enjoyable	0	25.0	11.1
Very Comfortable	26.7	58.3	40.7
Moderately Comfortable	73.3	33.3	55.6
Not Comfortable	6.7	8.3	7.4

* excluding Solowheel

By comparison, qualitative comments from the blog emphasised the fun experienced by some riders. PMDs were seen as a more enjoyable way of getting around campus.

Having fun on the Egret (it brings back loads of happy childhood memories of riding around on a scooter).

This was especially the case with the riders of the Solowheel, so much so that one rider remarked:

Sad face as I have to return the Solowheel today.

And another:

By the 3rd week (of using the Solowheel) I was comfortable enough to carry a coffee on it. So that became a fun morning activity.

ITEM 10 (continued) **ATTACHMENT 1**

The novelty of PMDs was remarked on by all riders, with many reporting that their trips were longer than anticipated because of being asked questions by pedestrians, as indicated in the following comments:

From students/pedestrian reactions, it all seemed mainly positive. My favourite overheard comment was "God, I'd love one of them right about now".

Qugo seems to attract a lot of attention from male colleagues. I was stopped quite a number of times on the road. They asked me about the features, e.g. what's the top speed, where is it made, where is the accelerator, etc.

These comments were invariably tempered by the practicalities of use, as described below.

Ease of Use

All riders found PMDs easier to use with practise, and all Egret riders found it easy to use, while 16% of Qugo riders found it hard to use. A number of advantages are identified in Table 11.

Table 11: Advantages of PMDs Compared to Previous Transport Mode (walking)

	Egret (%)	Qugo (%)	All (%)*
Faster	86.7	100	92.6
Expend Less Energy	26.7	33.3	29.6
Other	13.3	16.7	7.4

* excluding Solowheel

There were, however, a number of identified problems with riding a PMD on campus. Riders were asked to identify disadvantages, summarised in the table below and addressed in turn. Essentially, ease of use was compromised by perceptions of limited power, device weight, storage and portability, stairs and infrastructure (Table 12).

ITEM 10 (continued) **ATTACHMENT 1**

Table 12: Identified Disadvantages of PMD Use

	Egret (% of riders identifying)	Qugo (% of riders identifying)	All (% of riders identifying)*
Underpowered	46.7	25.0	37
Heavy	20.0	50	33.3
Too wide	0	41.7	18.5
Secure parking	20.0	33.3	25.9
Stairs	20.0	16.7	18.5
Infrastructure	13.3	25.0	18.5
Pedestrians	6.7	0	3.7

* excluding Solowheel

Power of Devices when Travelling Uphill

The devices were limited to 10 kilometres per hour through a limitation on power. A consequence of this was that devices struggled going uphill, or had to be pushed, and a widespread perception by riders that they were 'underpowered'. Almost 50% of Egret riders identified hills and being underpowered as the most common problem with their use of the PMD on campus.

The Egret is a slug up hill , on the flat it maintains its 10kp/h , downhill it accelerates beyond the 10 kp/h and you have to brake heavily . Big downside is uphill it's got nothing, having more acceleration would help this immensely.

The video analysis showed that in eight instances the participant was walking the PMD (mainly Egrets) and on five occasions Egret riders used their foot to either support their balance or to add leg power to the device to go up the ramp at the central hub.

Portability

PMDs are ideally portable, and in this trial riders were provided with quality bike locks to secure the devices to bike racks. However, most preferred to take (wheel, rather than ride) the PMDs into buildings, offices, meeting rooms etc. On the university campus this often meant negotiating stairs at some point, and difficulties with stairs and carrying PMDs were often identified disadvantages of the PMD.

After using the Egret for the week, I found it good to get across campus quickly, but overall it was more trouble than its worth in many cases. The size and weight of it make it bad for anywhere that requires it to be carried. If it were smaller and lighter, or if it collapsed to a smaller size this may be different.

Weight is a key component of perceptions of portability. At 15 kilograms Egret riders also identified its weight distribution and ease of folding as important and difficult, and half of Qugo riders identified its weight of 33 kilograms as a disadvantage. Storage and secure parking at diverse locations was also an issue – a device is not really portable if there is nowhere to store it at a destination.

Figure 14: Storing a PMD next to a Disability Scooter

As a result of these difficulties, a little more than half of the riders (52 percent) used the PMD less than they had anticipated. The differences between the devices were stark here: two-thirds of Qugo riders used the device less than anticipated, compared with 40% of Egret riders, and a third of Solowheel riders. The reasons for this reduction in use are shown in Table 13 below. Most notably, finding the device hard to use was not an issue for Egret riders, but was the third most important reason for using the Qugo less than anticipated.

ITEM 10 (continued) **ATTACHMENT 1**

Table 13: Reasons for Using the PMD Less than Anticipated

	Egret (% of reasons identified)	Qugo (% of reasons identified)	All (% of reasons identified)*
Walking Quicker	12.5	7.7	9.5
Walking more convenient	37.5	7.7	19.0
PMD too heavy	12.5	30.8	23.8
Ran out of charge	0	0	0
Problems with secure parking	25.0	23.1	23.8
Needed exercise from walking	0	7.7	4.8
Helmet annoying	12.5	7.7	9.5
PMD Hard to Use	0	15.4	9.5

* excluding Solowheel

Negotiating Infrastructure

The project design anticipated that road and path infrastructure, as well as connections between the two (kerb ramps, crossings, etc.) would be a determinant of ease of use. An initial infrastructure assessment was undertaken and minor changes made. Despite this, changes in surface, uneven surfaces and the increased elevation often associated with kerb ramps were identified as issues. 'Bumpy' rides induced by certain types of paving across campus were not appreciated, for example:

It does not ride well over rougher terrain (eg, car park, cobbled areas) and can give your back a jarring, especially if you are an 'older' person (Egret rider).

Increasing elevation was not anticipated to be an issue for the trial, but the hilly nature of the campus in conjunction with the means through which the PMDs were speed limited, became the most commonly identified problem. Video analysis identified a Qugo rider on one occasion struggling to get the device up onto the footpath in the absence of a curbside ramp. The only incident in use occurred on a narrow path with a Qugo, suggesting that path width is an important variable to be considered.

Sustainable Transport

Trial results are mixed in relation to the possibility of PMDs becoming a viable means of daily transport. Riders were asked about wider use of the PMD, and data on other factors that affect urban travel were also collected.

ITEM 10 (continued) **ATTACHMENT 1**

Speed – which is a known factor in instigating modal shift, was seen as a positive. Eighty-eight per cent of riders identified being able to get around campus faster with a PMD compared to their prior mode of campus travel (walking, or in one case cycling). Another identified advantage was expending less energy using the PMD. When specifically asked about wider use of the PMD, four-fifths of Egret One riders would use it to get to a transport hub if available, compared to half of the Qugo riders.

However, most riders (84%) also identified difficulties with PMD use outside the campus environment, principally in the areas of infrastructure, interactions with pedestrians and, in the case of the Qugo, its bulkiness (Table 14). The weight and portability of a device like the Qugo may not attract widespread use unless parking and storage facilities are provided. Moreover, in light of comments about weight and portability in the section on ease of use above, it is unlikely that PMDs in the specific form included in this trial would attract widespread use.

Table 14: Expected Difficulties in Using PMDs Off Campus

	Egret (% of factors)	Qugo (% of factors)	All (% of factors)*
Pedestrians	20	20	20
Infrastructure	53.3	26.7	40
Parking	6.7	13.3	10
Hills	13.3	0	6.7
Power	6.7	13.3	10
Too bulky	0	20	10

* excluding Solowheel

Comparison of Devices

Lack of consistency in research design curtails detailed and robust comparison of the devices. For information: of the 11 participants who trialled two or three devices, eight nominated the Egret as most effective in terms of flexibility, compared to one for the Qugo. In contrast, six participants evaluated the Qugo as most effective in terms of speed, compared to two Egret riders. Solowheel riders were satisfied with their device, but that is most certainly a self-selection effect and also because they had longer to become familiar with the device. Egret riders had less difficulty navigating through pedestrian precincts. The manoeuvrability of the device and the relative narrowness of the Egret made it easier to use on a diversity of path widths.

ITEM 10 (continued) **ATTACHMENT 1**

Trial Evaluation (5): Research Design

A critical aim of this trial was to lay the foundations for a larger trial across the Macquarie Park precinct by piloting the trial research design. Subsequent trials are dependent on funding, but the experience of this trial suggests that the following factors also need to be taken into account.

Design of the Trial

The original brief for this project was broad. It ranged across, for example, performance-based testing and standards for PMDs, the development of implementation guidelines for local government, with a particular focus on infrastructure, sustainable transport and infrastructure, as well as the social dimensions of PMD use. It was not possible to incorporate all these elements into the one research design, and, as acknowledged throughout this report, the 'naturalistic' design of the trial yielded significant insights into the practicalities of PMD use in a campus environment. However, the evidence base for performance and operating conditions, and infrastructure requirements is much thinner. It is therefore recommended that a two-dimensional approach to future trials be undertaken as explained in the conclusion and recommendations. The general parameters for discussion are as follows:

1. Investigation and evaluation of operational characteristics of PMDs, including controlled interaction with pedestrians. It is suggested here that PMDs be ridden in a small number of environments representative of the diversity encountered in slopes, surfaces, pedestrian density, etc. Riders would be under supervision, and interactions etc recorded through video. In this way, many of findings about the operational conditions of PMDs in different environments could be tested thoroughly.

It is envisaged that the campus environment remains an appropriate one for such a trial. The key difference is greater control over the conditions through which PMDs are ridden.

2. Investigation of the appropriateness of PMDs as a transport mode for short trips in congested urban precincts. One of the key starting points of this project has been that the use of PMDs as part of a multi-modal transport system is one of the principal reasons for considering their use. This study has shed some light on this question, though it has been overshadowed by mechanical and technological difficulties with the devices and trial conditions (e.g. power limiting) as well as the diverse range of rider competencies. With the understanding that these difficulties would be addressed in the first element of future research, this second element would again, in a controlled but naturalistic setting, ask riders to use PMDs in their daily travel behaviour; first as a means of getting around Macquarie Park during the day (as in the EasyConnect San Francisco study); and second as a means of getting to Macquarie Park.

ITEM 10 (continued) **ATTACHMENT 1**

Selection and Number of Devices

Throughout the trial the 'density' of PMDs on campus was low. Future research should incorporate a significantly greater number of PMDs, regardless of type, to study how riders manage in environments that are congested with other PMD riders as well as pedestrians.

This project deliberately trialed three very different devices and, as expected, very different results were obtained from each. In particular, the ease of operation of the two-wheeled versus three-wheeled devices varied, as did the ease of movement amongst pedestrians. Trial results suggest, nonetheless, that narrow and light devices such as the Egret have the greatest potential in terms of both integration into pedestrian environments and sustainable transport. These questions need to be examined carefully in future research.

Usage Protocols

The usage protocols described above were critical to the conduct of the trial. An evaluation of compliance in relation to wearing a helmet, disembarking to cross roads and not speeding was conducted through the video analysis, with the following results. Overall compliance was 71.5%. Compliance relating to wearing a helmet was highest at 97.5%, followed by not speeding (90%) and disembarking to cross the road (33%). The most frequent non-compliance was riding on Eastern Road, where 67% of PMD riders did not disembark to cross the road. In contrast there was 100% compliance on Wally's Walk, followed by Central Hub (91%) probably due to the absence of roads. A total of nine instances (7%) of speeding were captured. These were located at the Central Hub and Eastern Road by all devices.

Egrets showed the highest compliance at 78%. Here the most common non-compliance was not disembarking to cross the road (74%), followed by speeding, which was low at 6% and then not wearing a helmet (3%). The majority of Qugos were also compliant (68%). Here the most common non-compliance was again not disembarking to cross the road (67%), speeding (6%) and not wearing a helmet (2%). The Solowheel had the lowest compliance rate at 50% and the highest rate of non-compliance for not disembarking when crossing the road (80%). The Solo wheel also showed the highest level of speeding at 14% but was the only PMD to show 100% compliance with wearing a helmet.

It is important to put these compliance rates in relation to speeding and crossing roads in the context of the physical and social topography of campus. Campus design and anecdotal evidence suggests that in certain parts of campus (e.g. Eastern Road) the distinction between road and pedestrian path is unclear. This particular intersection presents as a pedestrian right-of-way, including a raised platform across the roadway. Speeding was identified on downhill parts of campus, where it is surmised that keeping the PMD below 10 km/h per hour may have been difficult.

Moreover, other trials of similar devices have likewise found that rider behaviour invariable exceeds protocols (Lavalle 2004).

Communication Strategy

While no formal evaluation of the communication strategy was conducted, anecdotal comments received by all members of the research team over the life of the trial suggest that there was widespread recognition of publicity of the PMD trial.

Insurance

This trial only proceeded on the basis that riders and pedestrians were covered by university insurances should any incident occur. Any geographical extension of the trial will have to address insurance issues.

Induction and Training

While riders were largely satisfied with the training received, it is also the case that riders noted that they improved with experience. A number of modifications are recommended for research and risk assessment purposes. Two incidents have also led to the requirement that defensive driving be added to the training, and that additional protective equipment (e.g. knee pads) be provided. It is worth considering whether a logbook of hours in particular conditions (e.g. inclement weather, heat) would be useful.

Appropriate ways to interact with pedestrians and behaviour on shared paths was emphasised in training, but it appears that some of this was forgotten in practice. A way to consolidate such behaviours – involving both pedestrians and PMD riders – will need to be found.

Conclusion and Recommendations

In a general paper announcing the trial, Faulks et al (2013) commented on the use of PMDs as alternative vehicles:

> "A PMD rider can travel short distances quickly. The electric-powered devices are reasonably environmentally friendly, an alternative to using a diesel or petrol-driven personal motor vehicle for short trips: based on similar costs for charging an electric bike, it is estimated that the monthly cost for charging a PMD for short trip distances will be less than $5. Portable PMDs can be easily integrated with public transport, making public transport more appealing if there's a long walk to the closest bus stop.
>
> So PMDs may address one of the key challenges in transport planning: reducing private car use for trips of less than 5km. For as much as we might think it desirable, people are reluctant to walk the 'first and last mile'. These journeys are most commonly made by private car, contributing to congestion, road safety risks, reduced air quality, and poor community amenity.
>
> The 2010/2011 NSW Household Travel Survey revealed that for trips of 1-2km, 67% were made by car either as a driver or as passenger, while only 25% were walked or cycled. For trips of 2-5km, 78% were made by car compared to less than 6% walking and cycling. In an average weekday, 48% of drivers used their cars for distances shorter than 5km.
>
> But there are more reasons to use PMDs than saving fuel and reducing emissions. For most people, daily travel coincides with periods of high demand on the road transport system. These 'peak hours' now extend for several hours and often result in severe localised congestion. Using public transport combined with PMDs for those first and last few kilometres of the daily commute could significantly reduce journey travel times and congestion."

The findings of the trial

The key findings are as follows:

Induction and training : Training in PMD use for research purposes is necessary and should incorporate navigational skills, avoiding static and moving objects, and interaction with unobservant pedestrians. Training should provide riders with the opportunity to practise on sloping and uneven surfaces.

Operating conditions : PMDs typically travelled around campus between a fast walking pace and easy jogging (6-8 km/h) and for trip lengths of between 500 and 1,000 metres. This would seem to indicate that distance travelled can be enhanced through PMD use, complementing walking or cycling.

ITEM 10 (continued) **ATTACHMENT 1**

Pedestrian interactions : The overwhelming majority of campus users were comfortable with and welcoming of the use of PMDs in pedestrian environments. In a university environment, on predominantly shared paths and with a limited number of PMDs, pedestrians and PMDs interacted harmoniously. PMD use is largely compatible with existing road and pedestrian infrastructure, especially for the lighter and narrower devices. Assistance with way-finding through signage, however, may be necessary to denote appropriate and convenient routes that PMD riders may choose for travel to different destinations (avoiding stairs, overly rough surfaces, etc.).

Rider experiences: All riders found PMDs easier to use with practise. All riders of the two-wheeled device found it easy to use, while one sixth of three-wheeler PMD riders found the device hard to use. Riders reported that the usability of all PMDs was compromised by the weight of the devices, portability and parking, and difficulties with hills. Most riders indicated their willingness to be able to use PMDs off campus or to public transport hubs. Some participants were observed to use a PMD less over the trial period. They reported that this was as their trips were short distances and walking was more convenient as the PMDs were too heavy and they had problems with parking or storage.

Design of future research: This was a limited trial, with a small number of participants and in a unique environment. Consequently, these findings are not generalisable in the scientific sense and cannot underpin widespread recommendations for change to regulatory frameworks of PMDs. However, the suitability of the university as a trial site for PMDs has been confirmed.

Future research

Based on these general findings, it seems appropriate to recommend that the trial be extended into public roads and paths both on and outside the Macquarie University campus as envisaged as Phase 2 of the study of PMDs in congested urban precincts.

Recommendation 1:

That the trial be extended into the Macquarie Park precinct. This extension should be aligned with the strategic plans of, and collaboration with, relevant agencies (e.g. Transport for NSW, City of Ryde, Macquarie Park Transport Management Association) and invite collaboration from any business or businesses in the precinct who wish to explore alternative transport options for their staff.

In this trial the lighter and narrower PMD proved easier to use and more manoeuvrable. Based on this finding:

ITEM 10 (continued) **ATTACHMENT 1**

Recommendation 2:

An extended trial be limited to use of light, narrow and portable PMDs, such as two-wheeled PMDs, on footpaths with appropriate speed limiting to no more than 10 km/h; consideration may also be given to other PMDs which may be used on public roads with higher speed limiting as appropriate.

The limitations in numbers and types of devices and numbers of riders should be addressed in future research.

Recommendation 3:

Further controlled experimentation be conducted on the Macquarie University campus to examine the interaction between PMDs, as well as the interactions of multiple PMDs with pedestrians in light and congested densities.

Resolving regulatory issues had an impact on this research and further research will be influenced by whether and how some of these issues can be resolved.

Recommendation 4:

A review of regulatory and insurance issues, and product standards as applicable to PMDs (rather than other alternative vehicles) be undertaken.

Notwithstanding the earlier discussion of the research findings and the recommendations made for future work, the evidence gathered in this trial suggests that any consideration of regulating PMDs and their use needs to take into account:

- Further examination of appropriate means of speed limiting,
- Training for PMD riders is advisable, and
- Education of both pedestrians and riders about shared paths is recommended.

ITEM 10 (continued) **ATTACHMENT 1**

References

Commonwealth Department of Infrastructure and Transport (2012). *Walking, Riding and Access to Public Transport*. Draft report for discussion, October. Canberra, ACT: Commonwealth Department of Infrastructure and Transport.

Commonwealth Department of Infrastructure and Transport (2013). *Walking, Riding and Access to Public Transport*. Ministerial Statement, July. Canberra, ACT: Commonwealth Department of Infrastructure and Transport.

Darmochwal, A. and Topp, H (2006). Segway in public spaces: Evaluation of the Saarland pilot trial with regard to the usage compatibility and the road traffic regulatory handling of these special transport devices. I. f. M. Transport. Kaiserslautern, Kaiserslautern University of Technology: 67.

Faulks, I., Irwin, J., Howitt, R., Dowling, R. & Zarafu, M. (2013). Electric unicycles, minifarthings and the future of urban transport. *The Conversation*, 6 May 2013. Website: https://theconversation.com/electric-unicycles-minifarthings-and-the-future-of-urban-transport-13331 Accessed: 6 May 2013.

Lavalle, P. (2004) Pilot project for Evaluating Motorized Personal Transportation Devices: Segways and Electric Scooters, Quebec: Transportation Development Centre, Canada.

Paine, M., Paine, D., Faulks, I., Griffiths, M. & Bailey, B. (2010). A national policy framework for alternative vehicles. Project RS1638 - Final Report. 31 December 2010. Sydney, NSW Austroads.

Paine, M. (2011). Safety requirements for small motorised alternative vehicles. Paper presented at the 22nd International Technical Conference on the Enhanced Safety of Vehicles (ESV), Washington, D.C., 13-16 June 2011. Website: http://www-nrd.nhtsa.dot.gov/pdf/esv/esv22/22ESV-000108.pdf Accessed: 30 May 2012.

Paine, M., Paine, D., Faulks, I. & Griffiths, M. (2013). Australian Road Rules for motorised wheelchairs and other motorised mobility devices. Project RS1731 - Discussion paper. May 2013. Sydney, NSW Austroads.

Rodier, C. and S. Shaheen (2004). Improving California's BART District Connectivity and Access with the Segway Human Transporter and Other Low Speed Mobility Devices Research Report. *California PATH Research Report*. Website: http://tsrc.berkeley.edu/sites/tsrc.berkeley.edu/files/Improving%20California's%20BART%20District%20Connectivity%20and%20Access%20with%20the%20Segway%20Human%20Transporter%20and%20Other%20Low%20Speed%20Mobility%20Devices%20Research%20Report.pdf Accessed: 2 July 2013.

Appendices

Appendix 1. Pre-, mid-, and post-trial Questionnaire

Pre-trial questionnaire

Demographic Questionnaire for *initial phase* of the PMD study

As part of this study, it is useful to collect information describing each participant. The following questions ask about you and your personal travel patterns on campus. Please read each question carefully, marking only one response unless otherwise specified. If something is unclear, ask the research assistant for help or clarification.

Your participation is voluntary and you have the right to not answer questions if you consider them to be overly intrusive.

Please answer the following questions about yourself.

1. What is your year of birth? _______

2. Membership Category of the University

   ☐ Academic Staff

   ☐ Professional Staff

3. Sex: ☐ Male ☐ Female

4. Do you hold a driver's licence? (Check only one)

   ☐ Full licence

   ☐ P1/Red provisional

   ☐ P2/Green provisional

   ☐ No driver's licence

5. Do you ride a bicycle on a regular basis? Yes ☐ No ☐

6. Do you ride a bicycle to university? Yes ☐ No ☐

7. How are you currently travelling around campus by

Walking ☐ Bicycle ☐ Other ☐ (please describe____)

8. Do you come by train/bus to university? Train ☐ Bus ☐ Neither ☐

9. Is access to the train/bus from your residence by:

Car ☐ Driven by someone ☐ Bus ☐ Walk ☐ Bicycle ☐ N/A ☐

10. Do you travel by car to university? As a: Driver ☐ Passenger ☐ N/A ☐

11. If you travel by car, is parking difficult? Yes ☐ No ☐ N/A ☐

ITEM 10 (continued) **ATTACHMENT 1**

12. Would a PMD be useful in getting from the station/car park to your lecture theatre/ office? Yes ☐ No ☐

13. Would such a device alter the times at which you arrive at University? Yes ☐ No ☐

14. If yes, would you now travel *during* the peak period ☐ or now *avoid* the peak period ☐ N/A ☐

15. Do you have a medical condition that may affect your ability to operate a PMD: Yes ☐ No ☐

16. If Yes, please state briefly below:

____

____

17. How often do you arrive late for lectures/ seminars/appointments etc. due to the amount of time consumed by walking?

Never	Occasionally	Frequently
☐	☐	☐

18. How often do you arrive late for lectures/seminars/appointments etc. due to the amount of time consumed by finding a parking spot?

Never	Occasionally	Frequently
☐	☐	☐

19. Would you see such a device as making your lifestyle more sedentary? Yes ☐ No ☐

20. Would you see such a device as making your lifestyle more active? Yes ☐ No ☐

21. How often do you move between different university buildings on a **daily basis**? 1-2 ☐times 3-5 times ☐ More than 5 times ☐

22. How would you describe walking between far locations on campus? Pleasant ☐ Tiring ☐ Exhausting ☐

23. What are the different belongings or items that you carry while moving around campus? (multiple-answers) Backpacks ☐ Handbag ☐ Laptop/tablet without bags ☐ Water bottle/Hot beverage ☐ Other? ________________

ITEM 10 (continued) **ATTACHMENT 1**

24. How far would you consider travelling using a personal mobility device?

0.5 to 1.0 km ☐ 1.0 to 1.5 km ☐ 1.5 to 2.0 km ☐ 2.0 to 4.0 km ☐ More than 4.0km ☐

25. What do you think could be barriers to use of a PMD in Macquarie University?

Limited shared space (i.e. access to use PMD) ☐

Distance between destinations ☐

Weather ☐

Safety ☐

Other

26. What do you know about PMDs?

____

27. Have you previously used a PMD? Yes ☐ No ☐

28. If so, tell us about your previous experience, e.g. how many times have you used one? What type?

____

29. Do you anticipate riding the PMD to be:

1	2	3	4	5	6	7
Very Easy	Easy	Somewhat Easy	Neutral	Somewhat Hard	Hard	Very Hard

30. Do you have any concerns about using a PMD? Yes ☐ No ☐

31. If so, what are your concerns?

____

32. Is there any other information you would like to add?

____

Post-trial questionnaire 1

Questionnaire for the *exchange* phase of the PMD study

1. How often did you use the PMD:
   a. Every day when I was in campus, regardless the distance travelled ☐
   b. Only if the distance between buildings /car-park is more than 500 metres ☐
   c. More than 1km ☐
   d. I stopped using the device ☐
2. How enjoyable to use was the PMD? Very ☐ Moderate ☐ Not at all ☐
3. How comfortable did you find it to ride? Very ☐ Moderate ☐ Not at all ☐
4. Have you encountered any drawbacks in using it due to:

		Often	Occasionally	Never
a	Balance	☐	☐	☐
b	Steering	☐	☐	☐
c	Coping with inclines	☐	☐	☐
d	Coping with stairs or kerbs	☐	☐	☐
e	Wearing the helmet	☐	☐	☐
f	Weight of the PMD	☐	☐	☐
g	Parking the PMD when not in use	☐	☐	☐
h	Carrying bags or any form luggage when using the PMD	☐	☐	☐
i	Finding sufficient shared space access routes	☐	☐	☐
j	Finding useable (unblocked, easy to trav-el) access routes	☐	☐	☐
k	Avoiding pedestrians	☐	☐	☐

l	Avoiding cyclists, skateboarders, and other PMD users	☐	☐	☐
m	Negative reactions from pedestrians and others	☐	☐	☐

5. Did it become easier with practice?

a) Yes	I now regard it as very easy to use	☐
b)Moderately	I feel that I am still learning how to use it	☐
c) No	I am still finding it difficult to use	☐

6. What **advantages** were there of using the PMD over your previous method of transport around campus?

____

____

7. Overall did you find riding the PMD to be:

a	b	c	d	e	f	g
Very Easy	Easy	Somewhat Easy	Neutral	Somewhat Hard	Hard	Very Hard

8. Did you use the PMD less than you anticipated? Yes ☐ No ☐

9. If so, it was because:

- a) It was quicker to walk ☐
- b) More convenient to walk ☐
- c) It was too heavy ☐
- d) It ran out of charge or hard to find a secure re-charging point ☐
- e) It was hard to find a secure place to park or store it ☐
- f) I needed the exercise from walking ☐
- g) The helmet was annoying ☐
- h) I thought it was unsafe/too hard to use/control ☐

ITEM 10 (continued) **ATTACHMENT 1**

10. What were the **disadvantages** of using the PMD over your previous method of transport around campus?

____

11. Would you consider continuing to use a PMD if it was supplied by the University on a permanent basis? Yes ☐ No ☐

12. Would you be interested in renting or sharing a PMD if such a scheme would be available? Yes ☐ No ☐

13. Would you consider buying a PMD for continued personal use? Yes ☐ No ☐

14. Would you consider using it reach a transport hub such as a railway or bus station? Yes ☐ No ☐ If so which one?

____

15. Do you foresee any difficulties using the device off campus? Yes ☐ No ☐

16. If yes, please list them:

____

17. PMDs are designed to be portable and able to be easily carried or taken onto trains and buses. Did you find the device . . .

a) Easy to carry /manoeuvre when you were not riding it? Yes ☐ No ☐

b) Easy to store /secure when you were not riding it? Yes ☐ No ☐

18. Did the PMD travel at the right speed? Yes ☐ Too fast ☐ Too slow ☐

19. How did you find interaction with other users of shared user paths?

Easy ☐ Difficult ☐ Frustrating ☐

20. What were the most common problems?

____

____

21. What advantages/disadvantages did you find using the PMD over your previous method of travel around the campus?

____

Questionnaire for the *exit* phase of the PMD study

1. How often did you use the PMD:
   a. Every day when I was in campus, regardless the distance travelled ☐
   b. Only if the distance between buildings /car-park is more than 500 metres ☐
   c. More than 1km ☐
   d. I stopped using the device ☐

2. How enjoyable to use was the PMD? Very ☐ Moderate ☐ Not at all ☐

3. How comfortable did you find it to ride? Very ☐ Moderate ☐ Not at all ☐

4. Have you encountered any drawbacks in using it due to:

		Often	Occasionally	Never
a	Balance	☐	☐	☐
b	Steering	☐	☐	☐
c	Coping with inclines	☐	☐	☐
d	Coping with stairs or kerbs	☐	☐	☐
e	Wearing the helmet	☐	☐	☐
f	Weight of the PMD	☐	☐	☐
g	Parking the PMD when not in use	☐	☐	☐
h	Carrying bags or any form of luggage when using the PMD	☐	☐	☐
i	Finding sufficient shared space access routes	☐	☐	☐
j	Finding useable (unblocked, easy to trav-el) access routes	☐	☐	☐

k	Avoiding pedestrians	☐	☐	☐
l	Avoiding cyclists, skateboarders, and other PMD users	☐	☐	☐
m	Negative reactions from pedestrians and others	☐	☐	☐

5. Did it become easier with practice?

a) Yes I now regard it as very easy to use ☐

b)Moderately I feel that I am still learning how to use it ☐

c) No I am still finding it difficult to use ☐

6. What **advantages** were there of using the PMD over your previous method of transport around campus?

____

____

7. Overall did you find riding the PMD to be:

a	b	c	d	e	f	g
Very Easy	Easy	Somewhat Easy	Neutral	Somewhat Hard	Hard	Very Hard

8. Did you use the PMD less than you anticipated? Yes ☐ No ☐

9. If so, it was because:

a) It was quicker to walk ☐

b) More convenient to walk ☐

c) It was too heavy ☐

d) It ran out of charge or hard to find a secure re-charging point ☐

e) It was hard to find a secure place to park or store it ☐

f) I needed the exercise from walking ☐

g) The helmet was annoying ☐

h) I thought it was unsafe/too hard to use/control ☐

10. What were the **disadvantages** of using the PMD over your previous method of transport around campus?

____

11. Would you consider continuing to use a PMD if it was supplied by the University on a permanent basis? Yes ☐ No ☐

12. Would you be interested in renting or sharing a PMD if such a scheme would be available? Yes ☐ No ☐

13. Would you consider buying a PMD for continued personal use? Yes ☐ No ☐

14. Would you consider using it reach a transport hub such as a railway or bus station? Yes ☐ No ☐. If yes, which one?____________________

15. Do you foresee any difficulties using the device off campus? Yes ☐ No ☐

16. If yes, please list them:

____

17. PMDs are designed to be portable and able to be easily carried or taken onto trains and buses. Did you find the device . . .

a) Easy to carry /manoeuvre when you were not riding it? Yes ☐ No ☐

b) Easy to store /secure when you were not riding it? Yes ☐ No ☐

18. Which PMD did you find to be the most effective in terms of:

a) Flexibility ____________________

b) Speed ____________________

c) User-friendliness ____________________

d) Safety ____________________

e) Any other ____________________

19. Which PMD was least effective? ____________________

a) Why?

____

____

20. Did the PMDs travel at the right speed? Yes ☐ Too fast ☐ Too slow ☐

21. How did you find interaction with other users of shared user paths?

Easy ☐ Difficult ☐ Frustrating ☐

22. What were the most common problems?

____

23. What advantages/disadvantages did you find using the PMD over your previous method of travel around the campus?

____

24. Do you feel the rules and protocols governing use of the PMDs were adequate?

Yes ☐ No ☐

25. If not why? How could they be improved?

____

26. Did the Induction Package adequately prepare you for using the vehicles?

Yes ☐ No ☐

27. If not why? How could the induction be improved?

____

28. If you had concerns in the pre-trial phase, have these been adequately addressed?

Yes ☐ No ☐

29. If not, please explain

____

____

Appendix 2: Brief questionnaire for pedestrians

1. Have you seen any Personal Mobility Devices (show pictures) on campus? Yes ◯ No ◯ (if 'no' end of interview).

2. Are you aged 18-30 ◯ 31-50 ◯ 51 or more ◯ years old?

3. How many times have you seen them? .... times. Which ones? E S Q

4. When you saw the PMD did you have to alter the direction you were walking? Yes ◯ No ◯ If yes, in what way?

....
....

5. Did you encounter any problem with any PMD? Yes ◯ No ◯ If yes, in what way? Do you recall where you were walking at the time?

....
....

6. If it was passing you, did you hear it coming? Yes ◯ No ◯

Comment (if any)

....

7. Do you think they are:

- Too noisy? Yes ◯ No ◯
- Too quiet? Yes ◯ No ◯
- Suitable to operate near pedestrians? Yes ◯ No ◯
- Unsuitable to operate near pedestrians? Yes ◯ No ◯
- Suitable for an enclosed space like MQ campus? Yes ◯ No ◯
- Suitable to operate on shared footpaths? Yes ◯ No ◯

8. Would you ride one if they were made available? Yes ◯ No ◯ Why?

....

....

9. Do you have any other observations or comments on PMDs?

....
....

....

Thank you for your time.

Appendix 3: Sample of Blog Comments

Attracting attention/reactions

An unexpected aspect of this - I am feeling 'on display'. Sharing space with pedestrians has elicited looks of confusion, bemusement and even derision. Being somewhat introverted this is a little uncomfortable.

Funny looks - if you ride an Egret One, expect some funny looks from pedestrians. The size, bulk, and inherent nerdiness associated with an electric scooter just asks for it.

Comments from Monday had religious overtones with "Oh my God" the catch phrase of the day. This transitioned to "awesome" by Wednesday and the occasional "I want one of those".

Riding around campus I had people I had never met before say hello.

Members of staff who know me stopped me and asked about it. There were some pointing and giggling and I overheard comments like "it's electric" and "I want one" but there have not been any hurtful comments.

Enjoyment

I have been without the Egret for about a week now. I kind of miss it. A cup holder seems like a good idea too.

Compared to the relative ease and portability of the Egret (I really, really enjoyed zipping around on it), after only 2 or 3 trips I feel as though I'm using the Qugo much more out of responsibility to the research project, than for comfortably helping me get around campus.

Hills and stairs

I was planning on riding the Egret to the gym- but with the incline, I will end up pushing it half of the time (so didn't).

I agree the Qugo is a hill slug, and when walking it up an incline, I quickly realised it was somewhat difficult to walk alongside / behind unlike the Egret (and I have long arms!).

Qugo (day2) - Getting the hang of driving around campus and think the term hill slug is apt but given its so heavy it is fairly easy to drive around campus if the speed limit can be lifted for hills.

It goes uphill, which means I have been finding new paths to avoid steps. The routes I end up taking are longer than what I would need to on foot, but the increased speed I get from the Solowheel evens that out (or makes it quicker).

Incidents

I had a scary encounter yesterday. The path leading from the hospital to E7B (not Wally's walk) is uneven but Qugo handled it ok. It is uphill in a few spots and Qugo was struggling along until a "driveway" came up with a downhill slant on an uphill path. Qugo almost tipped to the right and I had to jump off and pull it back and wheel it away. We're both OK.

ITEM 10 (continued) **ATTACHMENT 1**

Infrastructure

Not being able to ride on roads (as you would do with a bike, for example) meant my travel distance was doubled, using the paths best suited to the scooter.

What wasn't OK was the paved area between the old library and the Mac Shop/Co-op stores. It vibrated and shook me so much I got off and walked.

I have been negotiating many disabled access routes and finding how unsuitable they are for the Solowheel let alone a disabled person in a wheel chair or on crutches.

On the plus side, they're very durable! They travel over irregularities in the footpath and bitumen fairly easily, and also have no troubles with speed bumps, drains, grates, and tactile indicators. I haven't lost any balance or confidence in the ride when going over these common obstacles.

Lack of power

However the 10kph cap is really limiting the use of the scooter. It is impossible to go up inclines (even gradual ones) with the power being limited the way it is... numerous times I have had to get off the scooter as it cannot cope with the hills/inclines along the way.

I understand there is a safety concern, but considering people are riding regular scooters and bikes faster in the pedestrian areas without incident, I think this limitation needs to be addressed so the scooter can be properly evaluated.

Power - going up even a slight incline is a problem for the Egret. It just doesn't have the power to get up any sort of hill.

Not being able to go up hill is pathetic makes the Egret useless if you have to get around campus that isn't flat , when people are walking faster uphill while you're trying to balance at snail's pace or pushing it . If it wasn't speed regulated at 10 kms on the flat , downhill is another matter the scooter accelerates beyond the 10 kms and is heavy to brake. Doesn't make sense you need it to go slower downhill. Whoever speed regulated the Egret obviously didn't ride it on all gradients.

Still very sluggish up hills. I personally think there is a case for at least doubling the speed limit to improve its performance as there is very good braking and horn for safety.

Took it on a few trips to F9C, F9B, Security, Gym, F7B most times without a hitch till I came to a hill.

Pedestrians

Crowds - there aren't many people on Campus at the moment, and manoeuvring around those that are here has been quite easy as there's plenty of empty space.

Pedestrians observe with short glances (with a "what the hell" look) to longer gazes of curiosity. I had one pedestrian texting on the phone that walked straight into me. I had slowed in general anticipation and eventually came to an abrupt halt (read gentle dismount without *contact). As a general comment it's still hard to look into the faces to read expressions while also riding and anticipating walkers.*

Pedestrians are even more unpredictable than I expected - stopping suddenly, ignoring bells, etc.

From students/pedestrian reactions, it all seemed mainly positive. My favourite overheard comment was "God, I'd love one of them right about now."

I have however found it tricky at times to navigate around pedestrians when it is quite busy on campus and my thoughts are that it would be hard to monitor the speed people would be going around campus if these PMDs became legal to use. Because if people were going faster than 10km/hr and ran into someone that could cause great injury to a person.

Riding the scooter has also made me aware that so many people walk along the Uni not watching. Many have earphones in and are looking at their phone. This makes them an easy target for someone on a scooter.

Pedestrians seem to be reasonably comfortable with Egret around. When they hear the sound of the bell/engine, they move to one side.

Also, I'm getting more attention on this device (both good and bad). Two people have stopped me to ask if it was a Segway. I've also had a person tell me this was a lazy solution to getting around campus. I find pedestrians are much more aware of me on this device. It may be the sound of it coming or the size but I do find they make more of an effort to stay out of my way - a lot more than when I was on the Egret.

Secure parking

I have been carrying it up and down stairs into my office as I just don't feel confident leaving it chained up out of my sight.

I feel uncomfortable leaving Qugo locked at a bike rack because it is so valuable. I'm not worried about it being stolen. My concern is that it will get damaged by curious people who want to try it out because it looks "conspicuous" (unlike the Egret which looks like a scooter).

Technical issues

Build quality - Aside from the battery in mine not working, the structural build quality of the Egret is really good. Very solid aluminum, with large, strong joints and latches. The wheels and tyres are also beefy enough to withstand some lumps and bumps.

The throttle control is a little binary in nature. It has an 'all on, or all off' feeling to it. The best way to use it is to push off first, then apply throttle as you move off, which will allow complete control from a standing start. Hitting the throttle from a stand still results in a burst of acceleration, which could throw some lighter riders off balance.

My trips today all included elevators and awkward reversals out of them - maybe I'll work this out but I'm finding the backing in and backing out of these small spaces a bit tricky.

I really like the brakes. It's great that they can be used to adjust the speed when going downhill. One or both brakes can be pulled halfway to manage the "runaway" Qugo without cutting off the engine.

I feel like I need to concentrate more just to keep the Qugo device stable, change directions etc. Even though I've not been a regular scooter user, somehow the Egret's riding action felt more natural/instinctive to me.

As a PMD, Qugo has a number of good features: It's stable on flat surface. It's comfortable to ride on rough surface. It balances well on walking speed, about 3-4km/h. The speedo is very visible, big and clear. Some areas for improvement: Space between the handlebars and brakes is too big for my hands. I can't hold on both of them while riding. The parking brake is very hard to operate. It would be good if I can operate with one hand.

Up hill you had to lean forward to give front wheel traction and you would gradually get there at 2-4 kph. It's ergonomic except for the accelerator - doesn't seem to be in the right spot. It's ergonomic except for the accelerator - doesn't seem to be in the right spot.

Time

Used the Egret scooter for two trips so far, and it has reduced the amount of time I have spent travelling.

Travel time - Without many people around, the Egret cuts my travel time by about 2/3 from my office (Y6A) to the hospital end of Wally's Walk. Walking, It can take up 15 mins at a comfortable pace, or 10 mins power walking (after which you arrive very hot and bothered). On the Egret, it takes 10mins at the most, and, whilst I was still a bit hot and bothered after making the journey today in the sun, I definitely wasn't tired or a little bit out of breath or anything else like that.

I had a meeting that took me from my office in the BD building over to X5B - a trip I often underestimate in terms of travel time. Fortunately the motorised trip left me plenty of spare time, even negotiating the on-the-hour crowds of Wally's Walk.

I have been trialling a PMD (the Egret) for a week now and I have found it to be useful in terms of getting to other areas around Mac Uni campus much quicker than if I had to walk.

Weight of device

The Egret device is heavier than you might think when carrying it up several flights of stairs!

Weight: it is heavy, particularly if you are a female and have to carry it up stairs. It's also a little too heavy to take onto the train/bus.

The obstacles in getting the heavy/bulky device out of the elevator, turning it around, over the edge of kerbs, on and off at roads, etc, made me hesitant to take it out. The awkwardness with these movements is also making it (even more) conspicuous. NB: am feeling very thankful that we have lifts in our office, and generally don't have to negotiate stairs around campus.

Pilot Trial of Personal Mobility Devices at Macquarie University