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Electric bikes – cycling in the New World City: an investigation of Australian electric bicycle owners and the decision making process for purchase

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Abstract

Electric bikes have the potential to overcome some of the barriers that prevent Australians from riding a conventional pedal bike. Electric bikes offer assistance to overcome hilly terrain or a lack of fitness and they can assist in rehabilitation after injury or illness. While electric bike sales are increasing, they remain relatively uncommon and little is known about electric bikes in Australia. In this study, we identified characteristics of electric bike owners in Australia and explored the process and motivations of electric bike purchase.

An online survey was conducted of electric bike owners in Australia (n=529). In this paper, we analysed the demographic characteristics of electric bike owners and factors underlying the decision to purchase their electric bicycle. Particular attention is paid to the gender distribution of electric bicycle owners along with the reasons for purchase and the types of electric bikes purchased.

Electric bikes are a potentially important component in the mix of transport mode options. Accessible to a greater proportion of the community than pedal bicycles, electric bikes could enable more Australians to shift from cars and public transport for personal mobility. Such a shift will have direct benefits in relieving traffic congestion, easing the burden on the public transport system and offering independent mobility options. This study provides the first insights into this growing segment of transportation in Australia.

1. Introduction

The rate of cycling participation is increasing in Australia. In 2011, almost 4 million people (18%) rode a bicycle at some time during the previous year (Australian Bicycle Council and Austroads 2011). However, for many Australians there are objective and subjective barriers to cycling, including lack of fitness or the perception of fitness needed to cycle, hilly terrain, increasing age and injury or illness (Haworth 2012). An electric bike has the potential to overcome some of these barriers (Dill and Rose 2011; 2012; Rose 2012). Further, like a bicycle, an electric bike provides a travel option that has less environmental impact than a motor vehicle, while having greater capacity for the rider to travel further with less effort and carry heavier loads than a conventional bicycle (2012).

While electric bikes can potentially address many of the barriers to cycling, little is known about who owns electric bikes in Australia or how they made their decision to purchase. The aim of this study was to address this gap in the knowledge through analysis of an online survey of electric bike owners in Australia.

The paper begins by presenting a background of the growing market for electric bikes and research insights into the international experience of electric bike use. The study design and data analysis method is explained followed by the results from the online survey conducted. Subsequent sections discuss the decision making process to purchasing an electric bike, the characteristics of people who own electric bicycles in Australia and the types of electric bicycles owned. The final section presents conclusions of the paper and identifies some of

the gaps in the knowledge which inform suggestions for future research directions related to electric bicycles in Australia.

2. Background and existing knowledge

2.1 The expanding market for electric bicycles

Bicycles with power assistance, either through a throttle or when pedalling – also called pedal assist or pedelec – have commonly all been referred to by the umbrella term 'electric bikes' or 'e-bikes' (Rose 2012). For many years in Australia, the electric bike market was a boutique industry with few manufacturers or retailers. Some users created their own electric bike by retrofitting a bicycle with self-created components or via a conversion kit, often purchased online. Early commercial electric bikes were cumbersome, heavy and the range in terms of distance travelled on a single charge was short (Rose 2012). Early models also included a kind of hybrid scooter 'bicycle', operated by a throttle mechanism, the pedals were relatively ineffectual and it could not be powered by the pedals alone (Rose 2012). Limited designs were available in Australia but the electric 'bikes' were clearly identifiable as electric, with the battery position being the main point of difference (below the seat or above the back wheel) while the 'hybrid' style was often mistaken for a motorscooter (see Figure 1).

Figure 1. Electric bike models available in Australia (pre-2012)

Internationally, the electric bike market has expanded dramatically. To date, the largest international marketplace for electric bikes has been China. Sales of electric bikes grew from 40,000 in 1998 to 10 million in 2005, with an estimated 120 million electric bikes owned in China (Cherry and Cervero 2007; Weinert, Ma et al. 2007; Dill and Rose 2011). Electric bikes offer an affordable option to a motor vehicle or motorcycle yet have increased status to a bicycle in a growing economy. Similarly, in Europe there has been an increasing uptake of electric bike use, increased from sales of 300,000 in 2008 to almost 700,000 in 2010, however there is a greater emphasis on their use by older riders or people who have some physical illness or impairment (Hendriksen, Engbers et al. 2008; 2012).

Electric bike trials have been used internationally to better understand the viability of the electric bike as a transport mode. On a university campus in Singapore, McLoughlin and colleagues trialled trial of shared electric bike use had high patronage and satisfaction amongst students, which is promising in a hot and humid climate that is typically considered unsuitable for modes of transport that require physical exertion (McLoughlin, Narendra et al. 2012). The first electric bicycle sharing system in the US was successfully trialled at the University of Tennessee by Langford and colleagues, who reported growing interest in the system over the 12 month trial period. Although the main mode shift was from walking, the system provided an educational platform to introduce alternative transport options to thousands of students and staff (Langford, Cherry et al. 2013). Cappelle and colleagues reported on an electric bike trial of 250 participants over 2 years in Belgium and saw a mode shift for commuting, shopping and leisure; the shift was primarily from car, bicycle and public transport. Participants also reported time gains per trip which were calculated to a reduction

of 76 hours of traffic congestion for a single electric bike user (Cappelle, Lataire et al. Undated).

To date, Australia has not experienced the same uptake of electric bikes. While this may be due to a general reticence to cycle, it is very likely to be associated with the electric bicycles that are available in Australia. Internationally, power is limited to 250 watts in Europe and Japan with higher limits in the US and Canada (Rose 2012). In Australia the maximum permitted output was 200 watts, which restricted the models that could be imported commercially. However in mid-2012, the federal government changed the legislation to permit electric bike outputs up to 250 watts (Australian Government 2012). Although this regulation change is yet to be adopted in all jurisdictions, the increase to 250 watts enables importers to access the large international market of electric bike manufacturers and may lead to a step change in electric bike sales and use.

2.2 Electric bike owners

China is currently the country with the most electric bikes in the world. The combination of low income, high population density, short trip length and extensive cycling infrastructure contributes to the bicycle being the mode for 50 percent of trips in many large cities (Cherry 2007; Weinert, Ma et al. 2007). In an intercept survey of 460 electric bike riders in Shijiazhuang, Weinert and colleagues reported that the main reason for riding an electric bike to commute was that it was faster than a pedal bicycle, they didn't have to wait for public transport, it was a comfortable option and that public transport was too crowded (Weinert, Ma et al. 2007). In an intercept survey study conducted by Cherry and Cervero, half of electric bike riders in Shanghai and Kunming were female and the average age was mid-30's and few respondents had a car or motorcycle in their household. Compared to bicycle riders, electric bike riders were better educated and earned higher incomes (Cherry and Cervero 2007).

However, much of what is known about China, cannot be readily applied to the Australian context. The experience in countries with a lower bicycle mode share and a slower uptake of electric bikes is arguably more relevant for Australia where electric bike owners could be considered 'early adopters' (Dill and Rose 2011; Gordon, Shao et al. 2013). Surveys of electric bicycle owners (n=28) by Dill and Rose in Oregon, United States, reported that the average age was 48 years and almost half the owners were female and at least one motor vehicle was owned in each household (Dill and Rose 2011). The main reasons for purchase were to extend the trip range by bicycle, to replace car trips and environmental concerns. Gordon and colleagues, also interviewed electric bike users in Sacramento/Davis, California (n=24) and reported that participants were mostly male (63%) and had higher average levels of education and higher income than the averages for California (Gordon, Shao et al. 2013).

In Australia, little is known about electric bike owners or the process for deciding to purchase an electric bike. Currently, no records are kept of the number of electric bikes that are imported into Australia because the import documentation combines electric bikes with scooters and mopeds (Bourke 2013). This makes it impossible to determine how many electric bikes are available in Australia. In addition, conversion kits enable people to modify a conventional pedal bicycle into an electric bike and again no records are kept of these products. Finally, the internet provides the option to purchase electric bikes and conversion kits globally, and this too is not monitored or recorded. As a result, the total population of electric bike ownership in Australia is unknown and there is no knowledge of the factors that influence and inform people's decision to purchase an electric bike.

3. Method

An online survey was conducted with electric bike owners in Australia. Data collection was from November 2012 to March 2013. Study protocols were approved by the Monash University Human Research Ethics Committee.

3.1 Participants

Participants were electric bike owners and aged 18 years or older. A convenience sample was used. Several approaches were used to advertise the survey to potential participants. A short description of the study and the survey link were added to several websites (Monash University webpage and intranet, Amy Gillett Foundation webpage and social network page). In addition, all bicycle advocacy groups in each Australian state and territory were contacted with details of the study and the RACV promoted the study through social media. The survey was also publicised via an online article (The Conversation (Johnson 2012)) and in a radio interview (ABC Radio National).

3.2 Online survey

The survey was designed by the authors to investigate the decision making process to purchase an electric bike or convert a conventional bike to electric and to capture details of the electric bike and its use. The survey questions were developed following a review of the literature related to electric bikes. The first webpage of the study provided a detailed explanation of the study and informed consent was implied in the submission of the anonymous survey response. The survey was delivered online using the SurveyMonkey software.

3.3 Data analysis

In this study, we analysed survey responses to provide insight into the demographic characteristics of electric bike owners and the factors that contributed to their decision to purchase their electric bike, specifically: 1) demographics; gender, age, employment, education, income, residential location, relationship status, driver's licence and car ownership; 2) type of electric bike model owned, and; 3) decision making process; motivation for purchase and alternative transport modes.

Participant demographic characteristics are summarised using descriptive statistics and cross-tabulated with the type of electric bike owned (purchased, converted). Chi-square tests were conducted on the comparisons (Table 1). Descriptive statistics were used to summarise the type of electric bike purchased (Figure 2). Purchase decision making variables were summarised using descriptive statistics and cross-tabulated with gender. Chi-square tests were conducted on the comparisons. All statistical analyses were conducted using SPSS Version 18. Statistical significance was set at $p < 0.05$.

4. Results

In total, 529 electric bike owners completed the survey. The majority of electric bike owners in this cohort were male (71.1%); slightly more than half (56.8%) were aged between 41-60 years and, the over two thirds of respondents worked full time (67%) and almost half of respondents earned $100,000 or more (47.3%). Educational level was relatively high, with the majority having a tertiary or higher degree (70.2%) The majority of respondents also owned a vehicle (90.4%) (Table 1).

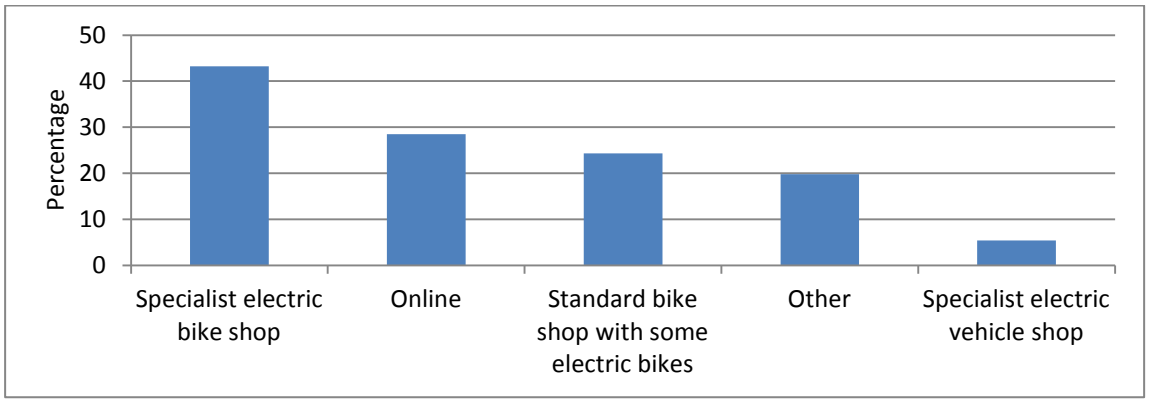
The cost of electric bikes ranged from zero (a gift) to over $10,000, the median price was $1,750.

Electric bikes were purchased from a range of locations, the most commonly cited source was specialist electric bike shop, followed by online. The range of locations the electric bikes were purchased from is displayed in Figure 2.

Table 1 Participant characteristics and vehicle ownership by type of electric bike (n=529)

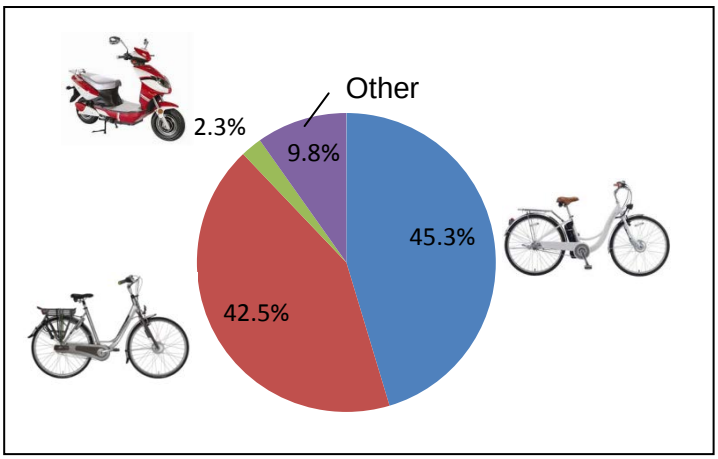
	Count	Percent	Type of electric bike				P value
			Purchased		Converted		
			No.	Percent	No.	Percent	
Total	529	100.0	347	65.6	182	34.4	
Gender							
Male	376	71.1	216	57.5	160	42.5	
Female	153	28.9	131	85.6	22	14.4	0.00
Age							
19-30	26	4.9	12	3.5	14	7.9	
31-40	89	16.8	47	13.9	42	23.6	
41-50	143	27.0	82	24.2	61	34.3	
51-60	151	28.5	120	35.4	31	17.4	0.00
61-70	76	14.4	55	16.2	21	11.8	
71+	32	6.0	23	6.8	9	5.1	
Employment							
Work full time	292	55.2	172	51.7	120	67.0	
Work part time	92	17.4	73	21.9	19	10.6	
Retired	90	17.0	66	19.8	24	13.4	0.00
Student	16	3.0	8	2.4	8	4.5	
Other	22	4.2	14	4.2	8	4.5	
Education							
Primary school	1	0.2	0	0	1	0.6	
Partial secondary	3	0.6	2	0.6	1	0.6	
Secondary	50	9.5	35	10.5	15	8.3	
Technical school/TAFE	99	18.7	55	16.5	44	24.3	0.16
University degree	222	42.0	144	43.1	78	43.1	
Higher degree	140	26.5	98	29.3	42	23.2	
Income							
Less than $20,000	30	5.7	19	5.8	11	6.3	
$20,000-$39,999	46	8.7	27	8.3	19	10.9	
$40,000-$74,999	104	19.7	71	21.7	33	19.0	0.66
$75,000-$99,999	84	15.9	60	18.3	24	13.8	
$100,000-$149,000	133	25.1	85	26.0	48	27.6	
Over $150,000	104	19.7	65	19.9	39	22.4	
Location							
Victoria	148	28.0	89	26.9	59	34.3	
New South Wales	118	22.3	71	21.5	47	27.3	
Queensland	68	12.9	47	14.2	21	12.2	
Western Australia	68	12.9	46	13.9	22	12.8	0.95
Australian Capital Territory	49	9.3	39	11.8	10	5.8	
South Australia	22	4.2	15	4.5	7	4.1	
Tasmania	25	4.7	21	6.3	4	2.3	
Northern Territory	5	0.9	3	0.9	2	1.2	
Relationship status							
Single	114	21.6	72	21.6	42	23.7	
Married/long term relationship	396	74.9	261	78.4	135	76.3	0.57
Driver's licence							
Yes	491	92.8	317	93.5	174	97.2	
No	27	5.1	22	6.5	5	2.8	0.05
Own a car							
Yes	478	90.4	309	90.6	169	94.4	
No	42	7.9	32	9.4	10	5.6	0.08

Figure 2 Where electric bikes were purchased



The majority of participants owned an electric bike (87.9%), as distinct from the model that looked like a motorscooter (Figure 3).

Figure 3 Types of electric bikes owned by participants



However, almost 10 percent of respondents did not answer this question and it was apparent from comments received that none of these bikes represented in the question reflected the electric bikes which were owned by these respondents. The survey was not designed for respondents to be able to provide details of their bikes beyond the three options above.

The decision to purchase an electric bike or convert a pedal bike was significantly different for four variables: gender, age, employment status and driver's licence. Of these four variables, the greatest difference was by gender with almost all females purchasing their electric bike while a minority of females (n=22, 4.1%) owned a converted pedal bike. The motivation for purchase cited by the majority of participants (59.5%) was to replace some car trips, followed by to ride with less effort (49.3%). To improve fitness and because the respondent lived in a hilly area were also commonly cited with differences between male and female respondents. The majority of respondents considered other models prior to purchase but the difference between males and females was not statistically significant.

Finally, participants were asked about alternative transport modes that they had considered prior to purchasing their electric bikes. Half the respondents did not consider an alternative with similar proportions being reported for male and female participants. Of the remaining travel options, the order of consideration was bicycle, public transport and motorscooter, with

no significant difference between females and males. However, consideration of a motorbike was significantly different with more males considering a motorbike than females.

5. Discussion

This online survey study provides new insights into people who have purchased electric bikes in Australia and their decision making process.

5.1 Electric bike owners in Australia

The majority of electric bike owners in this cohort were male (71.1%) which is higher than the proportion of males who ride pedal bicycles (64.4%)(Department of Communications Information Technology and the Arts 2011). Over half of the respondents (56.8%) were aged between 41-60 years and, the over two thirds of respondents worked full time (67%) and almost half of respondents earned $100,000 or more (47.3%). The age and working status is perhaps not surprising, given that the average price of the electric bikes owned was $1,750. Educational level was relatively high, with the majority having a tertiary or higher degree (70.2%) however, this may be a function of the recruitment methods as much as electric bike owners being highly educated. While this is not an expensive form of transport in comparison to a vehicle, as the majority of respondents also owned a vehicle (90.4%), it is an expensive secondary form of transport.

Responses were received from across Australia, however given the lack of data on electric bike ownership, and/or sales, it is not possible to determine how representative our sample is of the total electric bike owner population. Almost all electric bike owners also have a current driver's licence and own a car. This suggests that for many electric bike owners, the electric bike provides a supplementary transport mode.

5.2 Converted electric bikes

Much of the literature has focused on electric bike use, barriers to use, environmental impacts and benefits (Cherry 2007; Cherry 2008; Dill and Rose 2011; Gordon, Shao et al. 2013). While there is also a large literature on the specifications of commercial electric bike models (Cherry and Cervero 2007; 2012; Rose 2012), there is a lack of evidence about converted electric bikes; yet in this cohort, almost a third of respondents had converted a pedal bike. Given the availability of conversion kits in stores and via the internet, the proportion of electric bike fleets internationally that consist of converted pedal bikes needs to be better understood.

Currently in Australia, pedal bikes converted into electric bikes are mainly owned by men, across all age groups, education and income levels. Conversions may have been the only available option as electric bikes have not been readily available commercially across Australia until relatively recently, however this group is also likely to be interested in the technology of the electric bike and possibly gain enjoyment from the process. While this proportion may decrease as more sophisticated electric bikes enter the Australian market, it is likely that there will always be a proportion of electric bike users who continue to invent new and improved ways to power their bicycle.

5.3 Decision making process to purchase

Information gathering is a key component in addressing the uncertainties related to a purchase of a new or untested item (Edwards 1967). In this cohort, the internet was the most commonly used source of information for both males and females electric bicycle owners. This is not surprising, given that the internet is now frequently used to compare products and understand new technologies. Advice from retailers was an information source for a fifth of electric bike owners, however, almost a quarter of female respondents sought advice from a friend or colleague who already owned an electric bike. Clearly, information sharing from a trusted source was an important factor for women. The importance female electric bike

owners placed on the advice of others was also evident in who was involved in the purchase. Two thirds of women involved someone else in the decision making process, either a family member, friends or staff in the shop. By contrast, over two thirds of males made the purchase decision alone.

The most commonly cited motivation for purchasing for all respondents was to replace some car trips. Daily mode choice is reliant on vehicle availability (Rose 2012). For electric bike owners in Australia, as in the US (Dill and Rose 2011), vehicle ownership is high and there has traditionally been a default reliance to travel by private car. The appeal of replacing some car trips varied, including concern for the environment, to save fuel and money and for short trips close to home. Many participants commented on the additional luggage carrying capacity of an electric bike, compared to a conventional bike, to be an important practical necessity in replacing car trips.

Environmental benefits of the electric bike were noted by several participants as a motivation for their purchase. Interestingly in China, there is some contention over the environmental credentials of the electric bike as the embodied costs of production and concerns about lead acid batteries in early models have led to some cities introducing policies to reduce or ban electric bikes (Cherry 2007; Cherry and Cervero 2007). More recent developments in electric bikes, particularly in the battery technology has seen the lead acid batteries being replaced with nickel-metal hydride or lithium ion batteries, although the additional purchase cost when these are installed on an electric bicycle may be a deterrent (2012; Rose 2012). Comparisons of electric bikes with cars and buses have reported that per kilometre travelled, even taking into account the longer lifespan of the automobiles, the electric bikes are very energy efficient and cleaner than cars on all metrics, with the exception of those using lead acid batteries (Cherry 2007).

6. Conclusions and research directions

Given that Australia has adopted the European regulatory standards, the range of electric bicycles available for purchase can be expected to expand and ownership and use is likely to grow accordingly. Deeper understanding of the purchase and use of these vehicles is potentially of value to both the retail sector and transport policy makers. Importantly this study has identified that rather than purchasing a complete electric bicycle, there is a substantial retrofit sector in this market. Continued acceleration of purchases made over the internet could see further growth as potential users become aware of the option of electric bicycles.

The online survey obtained information from over 500 electric bicycle riders in Australia. Nearly three quarters of them were male, about 20 per cent were over 60 years of age and over two thirds worked full time on relatively high incomes perhaps reflecting their relatively high level of education (nearly three quarters had a tertiary or higher degree. While about 90 per cent of respondents owned a motor vehicle, nearly 60 per cent of them indicated that the reason for purchasing an electric bicycle was to replace some car trips while for about half it was also to ride with less effort. The results here are at odds from previous research which as suggested that electric bicycles may be more likely to appeal to female riders – although as noted below, that could be a function of those who were aware of and chose to respond to this survey rather than being representative of electric bicycle riders in Australia. While women accounted for only a quarter of respondents, important gender differences were identified in the responses. More males were likely to have given some consideration or detailed consideration to the technology of the electric bicycle (different motors, power outputs, battery capacities and battery types) and were also more likely to have considered a motorbike as on option to the electric bicycle purchase than females.

This is the largest study to date of Australian electric bicycle owners. It has provided important insight into the factors driving ownership and use. However the respondents are potentially unrepresentative of the electric bike owner population in Australia. As there are no

records of the number of electric bikes owned in Australia, it is not possible to determine how representative the sample is and therefore we cannot generalise our findings to all electric bike owners. However, as this is one of the first studies of this population, the findings provide important baseline data for future electric bike research both in Australia and internationally. As transport authorities seek to enhance the sustainability of urban transport systems by encouraging use of low impact modes, further research on electric bicycles is likely to provide valuable insight to underpin policy development in relation to this mode. Valuable insight could be obtained from more closely studying the behaviour of electric bicycle purchasers to gain insight into how access to an electric bicycle changes their travel behaviour.

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