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消費者對電動機車共享使用意圖之推理探究

EXPLORING CONSUMER REASONING IN USAGE INTENTION FOR ELECTRIC SCOOTER SHARING

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摘　要

近年來，電動機車共享機制在全世界普遍推廣，臺灣也不例外，然而，過去研究甚少深入探討消費者對於電動機車共享之使用意圖。本研究探討潛在使用者支持和反對使用電動機車共享的理由、使用意圖、潛在旅次目的和運具轉移情形，以及受訪者對行動共享和電動車輛的經驗和態度。本研究藉由開放式問卷調查探討消費者使用電動機車共享的支持和反對理由，採用質性和量化方法分析所收集在台灣就讀大學的本國生與外籍生的問卷資料。

研究結果支持後續探討在不同情境下跨國與不同文化背景消費者之電動機車共享使用意圖。消費者對於電動機車共享使用的支持與反對原因具有不同的結構和重點，應該進行區別調查。旅次運具使用調查發現使用電動機車共享的可能潛在後果隨文化背景不同。本研究結果為運輸研究人員，規劃人員和決策者提供了進一步調查電動機車共享潛在影響的基礎，後續也可以根據本研究的結果發展量化研究。

關鍵詞： 動力兩輪車；電動機車共享；支持和反對理由；質性內容分析；探索性因素分析

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ABSTRACT

In recent years, sharing-schemes for electric scooters have been established globally, also in Taiwan. However, hardly any studies have furthered the understanding of electric scooter sharing adoption among consumers. This study explores the reasons among potential users for and against using electric scooter sharing, their usage intentions, potential trip purposes and mode shifts, as well as respondents' experience with and attitudes toward shared use mobility and electric vehicles. A survey with open-ended questions was undertaken to explore the reasons for and against among consumers to use electric scooter sharing. We employ qualitative and quantitative methods to analyze data collected among university students in Taiwan.

Our results encourage investigating electric scooter sharing usage intentions across countries or cultures globally in different contexts. Consumers' reasons for and against using electric scooter sharing display different structures and emphasis, and should be investigated in distinction. Findings on trip modes point out desirable and undesirable potential consequences of electric scooter sharing use, depending on the cultural context. The results provide transportation researchers, planners and policy makers with a baseline for further investigating the potential impact of electric scooter sharing. Quantitative surveys can be developed based on the findings of this study.

Key Words: *Powered two-wheelers; Electric scooter sharing; Reasons for and against; Qualitative content analysis; Exploratory factor analysis*

I. INTRODUCTION

Over the past years, many e-scooter sharing (ESS) operations have appeared around the world. While other e-mobility and shared mobility concepts are well researched, ESS remains a white spot. In particular, what are the reasons that drive consumers to use or not to use ESS is not understood. Other mobility concept might offer lessons and pointers to this question. However, distinctive characteristics of ESS (e.g. helmet requirement) when comparing for example to car or bike sharing limit the transfer of insights.

This study explores in-depth consumer reasoning for and against ESS via a pen-and-paper survey among university students in Taiwan by utilizing a combination of qualitative and quantitative data analysis. University students represent a significant part of current travelers – approx. 1.3 million in 2016 [1], and a majority of future working population – since 2013 over 70% enrollment in higher education [2]. The students who participated in the survey took transportation management related courses at National Chiao

Tung University. Their potential future roles as decision or policy makers especially in the field of traffic and transportation renders them a relevant group of interest.

In line with the goal of in-depth reason exploration and analysis, we use Qualitative Content Analysis (QCA) to form reason categories from answers to open-ended questions. These categories are analyzed together with other quantifiable responses. In order to explore reason structures we perform exploratory factor analysis (EFA), which allows underlying grouping to emerge. The EFA confirmed the formed categories and their dichotomous nature as reasonable. The results of our analysis can inform transportation planners and policymakers, and guide future research.

1.1 Background and motivation

Spreading ownership and the use of motor vehicles is widely seen as a symptom of unsustainable transport [3]. They contribute in major ways to climate change, air pollution [4] and oil dependence [5]. Motor vehicle owned globally exceed 1.7 billion units [6], but only a tiny fraction are electrically powered [7]. Much of urban mobility demand is met by private vehicles, of which powered two-wheelers (PTW) significantly contribute to air pollution [8]. In order to reduce the negative effects of individual transportation, electric mobility is increasingly being adopted worldwide. Most electrification policies aim to improve local pollution levels and to mitigate climate change by tapping into renewable power sources [9]. From a lifecycle perspective, electric motorcycles have the potential to reduce energy consumption and harmful emissions [10]. Thirty per cent of globally registered motor vehicles are PTW [11]. Most are in Asia, where sixty per cent of vehicles were PTWs. Taiwan has one of the highest densities of PTWs in the world, with two motorcycles for every three citizens, and a total number of 13.7 million. Motorcycles occupy a lot of space on roadsides, sidewalks and other public spaces.

Commercial sharing concepts for cars and bicycles have been on the rise for decades[12]. Vehicle sharing can mitigate land use issue, due to a reduced number of needed vehicles [13]. In recent years, many stationed and free-floating sharing-schemes for electric scooters (ES) were established. Typically, a car-driving license and wearing of a helmet are required. Most ESS operators provide one or two helmets, sometimes with hygienic head-caps. Smartphone applications are used to locate, access and return ES. Operator staff typically swap batteries. The integration of ESS into urban transportation systems could mitigate big city challenges, such as air quality, noise and greenhouse gas emissions, as well as road congestion. However, negative effects on road safety and cannibalization of public transport could be a concern.

The number of cities with ESS operations in the world is growing quickly. ES combine

urban car speed with two-wheeler flexibility. Powered two-wheelers are attractive and distinct from other modes, offering cheap, fast and flexible travel at low cost. They are more readily accessed due to easy parking, and offer high route and scheduling flexibility [14]. What effects are to be expected from their introduction in urban areas is a question for transportation planners and policymakers. In order to further the understanding of potential impacts on personal transport decisions and mode choices, the purpose of this study is to understand the breadth of consumer reasoning for and against using ESS.

1.2 Literature review and research gap

Despite an increasing proliferation, hardly any studies have furthered the understanding of ESS adoption. Degele et al. [15] identified market segmentation based on data from an ESS operator in a big German city. However, the authors based their study at early adopters of an ESS service, rather than the vastly bigger group of potential adopters of this relatively new transport mode. Tsai [16] included an ES rental option in a survey among tourists about their mode choices on Kinmen, Taiwan. The success of car- and bike-sharing schemes around the world may offer some indications, however, research on other shared modes or general motorcycle use does not account for the specifics of ESS. Research frequently discusses car-sharing [17–19]. The use of electric vehicles (EVs) in car-sharing systems reduces carbon emissions [20]. Numerous studies found car sharing to have decreasing effects on vehicle ownership, number of vehicles on the road, vehicle distances travelled, and greenhouse gas emissions [21,22]. Car sharing members may increase their use of alternative modes. However, modal shifts caused by car sharing may lead to a slight overall decline in public transit use [21].

A look at bike sharing suggests that in larger urban areas it frees capacity of bus and rail networks. While in smaller cities, it improves connectivity to and from bus lines. Generally, bike sharing appears to result in a considerable decline in personal driving and taxi use, suggesting that public bike sharing is reducing urban transportation emissions [23]. For example, in Washington D.C. modal shift caused by bike sharing happened in favor of bus and rail for people who live on the urban periphery. However, those living in the city center use public transport less. In Minneapolis, a mid-size city, the shift toward rail extended to the city center, but the modal shift for bus usage is more scattered [24].

Past literature has specifically explored travel behavior of university students [25–28]. Students represent an important share of the travelling population in many cities and regions [29] and are the main demographic using existing ESS services [30]. Their characteristics are different from other passengers as they often use a wider range of transport modes [26]. Their daily schedule tends to be more flexible than among the working population [31]. Policy often

encourages the use of more sustainable modes (e.g. public transport, bike sharing, walking) aiming at university students, because in the short-term positive effects on health, congestion and air quality are expected. While in the long term it is hoped that transportation habits and choices become more environmentally responsible and eco-friendly [32].

Qualitative methods typically aim to achieve depth of understanding while quantitative methods' purpose is breadth of understanding [33]. By continuing to sample until no new substantive information surface, a comprehensive understanding of the material under study can be achieved [34]. In order to reach saturation in acquiring information, qualitative methods often have an emphasis of homogeneity in their sampling [35–37].

Various theoretical approaches suggest that people's reasons serve as the underlying determinants of behavior [38,39]. Reasons Theory [40] suggests that reasons motivate behavior and help people justify and defend their actions [41]. People use justifiable reasons for "pursuing a particular goal" [42], and such justifications are critical in the reasoning process [43,44]. Changing behavior would only succeed if reasons underlying the behavior are addressed [45,46]. Hence, policymakers, planners and ESS operators likely have a higher chance to influence traveler behavior, if they have knowledge about the underlying reasons.

Our study differs from previous shared mobility research in that it not only focusses exclusively on ESS, but also specifically investigates potential adopters rather than existing early adopters. In addition, we do this in a qualitative format that allows influences and factors, specifically reasons, which a priori may not have been hypothesized to emerge.

1.3 Research objective and overview

The purpose of this study is to explore the reasons among potential consumers for and against using ESS among a homogeneous and relevant subpopulation in Taiwan. Data from a qualitative pen-and-paper survey with open-ended questions is analyzed using qualitative and quantitative methods that complement each other. The results inform about respondents' reasoning structure, potential trip purposes and mode shifts, as well as respondents' experience with and attitudes toward shared use mobility and electric vehicles.

In Section 2, we explain the research methods employed during data collection, qualitative and quantitative analysis. In Section 3, the results of our analyses are presented and discussed. Finally, we touch on limitations of our study and make concluding remarks in Section 4.

II. METHODOLOGY

2.1 Data collection

In line with our exploratory goal, we purposefully sampled from university students in Taiwan. A survey was conducted by paper questionnaire between Dec 2017 and Feb 2018 among students of transportation research related graduate courses at National Chiao Tung University, Hsinchu (Taiwan). In total 129 returned questionnaires were valid. The sample consisted of 98 local and 31 foreign students. A short oral/visual explanation informed about ESS. The questionnaire contained a brief explanation on ESS and web links to a Taipei ESS provider website. Three sections with questions followed.

The first section asked open-ended to provide three reasons for (RF) and three reasons against (RA) ESS use (e.g. “Please name three reasons why you would want to use e-scooter sharing!”). The second section asked open-ended what trip purposes the respondent would use ESS for (“I prefer to use e-scooter sharing to replace trips I make for the purpose of: …”), and by what mode such trips were currently undertaken (options: scooter, car, walk/bicycle, bus/train). The third part asked about attitudes toward ESS, shared and e-mobility in general and usage intention of ESS. Respondents could indicate agreement with statements regarding attitudes (e.g. “E-scooter sharing is a good idea”) and usage intention (“I will use e-scooter sharing when I have the chance”) on a 5-point Likert scale from “disagree” to “agree”. At the end, prior experience with shared and e-mobility was inquired (“I used an electric vehicle (a sharing system) before” with answer options: none, scooter, car, walk/ bicycle, bus/train).

2.2 Qualitative Content Analysis

Responses were first translated from Chinese to English. Next step was the inductive category formation of the first question section about respondent’s RF and RA using ESS [47]. We coded responses by looking for clear semantic elements that formed concrete RF or RA using ESS in a form that could also appear in the answers of other respondents. Reasons are the specific subjective factors, which people put forward to explain a stated behavior intention. There are two (dichotomous) sub-dimensions: “reasons for” and “reasons against” performing a behavior [38,39,48].

Codes were formed from responses, not pre-defined. After a first run of coding of 30% of the questionnaires, coding rules were reviewed and revised. We formulated categories by combining semantically closely related codes. In addition, a frequency analysis of codes and categories was done (Table 3). The material was given to an external expert for review. The

adequacy of our coding was discussed and some changes were made to the coding rules and system. In a final coding run, the entire material was analyzed again following the revised coding system.

Table 1 Previous experience with shared and electric mobility.

Local (N=98)	none	scooter	car	bike	other
e-mobility	62	28	3	13	0
	64%	*29%*	*3%*	*13%*	*0%*
shared use	17	9	7	74	0
	17%	*9%*	*7%*	*76%*	*0%*
Foreign (N=31)	none	scooter	car	bike	other
e-mobility	17	3	6	9	0
	55%	*10%*	*19%*	*29%*	*0%*
shared use	4	2	11	23	1
	13%	*6%*	*35%*	*74%*	*3%*

Table 2 ESS usage intention and attitudes toward ESS, shared and electric mobility.

Local (N=98)		**1**	**2**	**3**	**4**	**5**	**μ**	**σ**
Attitude	e-mobility	0	6	17	38	36	4.1	0.89
	shared use	2	4	13	27	52	4.3	0.98
	ESS	1	4	8	39	46	4.3	0.86
Intention	to use ESS	2	4	12	28	52	4.3	0.97
		2%	*4%*	*12%*	*29%*	*53%*		
Foreign (N=31)		1	2	3	4	5	μ	σ
Attitude	e-mobility	0	0	3	5	23	4.6	0.66
	shared use	0	0	0	7	24	4.8	0.43
	ESS	0	0	3	8	20	4.5	0.70
Intention	to use ESS	0	2	5	6	18	4.3	1.07
		0%	*6%*	*16%*	*19%*	*58%*		

Scale: 1 = disagree, 5 = agree

2.3 Data analysis

Based on the coding results and the responses from the other questionnaire sections, the data was analyzed in several ways. First, descriptive statistics such as frequency counts of categories, cross-tabulations were used to explore the data. Second, we calculated bivariate Pearson correlation of all main categories separated into RF and RA, as well as attitudes, usage intention, prior experience with sharing or e-mobility, and current mode choices. From this, we could confirm a number of expected relationships among the main categories of reasons.

Next, we employ exploratory factor analysis (EFA). EFA is designed and most appropriate for exploring a data set, especially, in the absence of the goal to test hypotheses. The idea of EFA is to uncover underlying structures in a dataset and is applied when these structures are not well known. In our case, no prior research has elicited reason structures, drivers or obstacles regarding ESS adoption. The primary interest is to find out what the number of existing influencing factors is, and to quantify the strength of the relationship between manifest variables and extracted factors. Therefore, before developing a survey instrument to test and confirm hypothesized factor structures and relationships, an exploration of potential influencing factors is appropriate. That means, for our purpose the application of EFA rather than confirmatory factor analysis (CFA) is indicated.

Third, a two-stage EFA with all main categories stated by more than five people (see Table 3) was conducted. In the first stage, an EFA of RF and an EFA of RA were conducted. In the second stage, the five extracted factor groups were pooled for another EFA to confirm a dichotomous reason structure. Fourth, a one-stage EFA with RF and RA pooled was undertaken to explore an overarching group structure. We employed principal component analysis (PCA) with oblique rotation and Kaiser Normalization in all EFA using SPSS 22.

Finally, we use a logit model to control for different variables that influence ESS usage intention.

III. RESULTS AND DISCUSSION

3.1 Local students versus foreign students

The number of foreign students in our sample was small (N=31). They predominantly originated from Europe. On the one hand, the small number limits meaningful quantitative analysis on its own. On the other hand, a pooled (foreign and local) qualitative analysis is

not in line with our homogeneity requirement. Because they come from a different cultural, social and geographical background, we must assume that including them would make for a much more heterogeneous sample. We did conduct QCA for the foreign student group and present results separately from local students, but we do not consider them during the EFA. Nevertheless, the following obvious differences between the two groups are worth reporting and, indeed, motivate further research.

Experience with car sharing (35% vs. 7%) and e-bikes (29% vs. 13%) was notably higher among foreign students (Table 1), while a higher share of local students had used an e-scooter before (29% vs. 10%). Stated trip purposes for potential future ESS trips were similar among local and foreign students. Only leisure trips were somewhat more frequent among foreigners (17% vs. 7%). When stating with what transport mode such trips are currently undertaken, scooter use was significantly higher among locals (39% vs. 9%). In contrast, foreign students reported that they currently often use non-motorized modes (walk/bicycle, public transport) for potential ESS trips (82% vs. 51%). Local students stated less positive attitudes and more diverse (smaller standard deviation) than foreign respondents towards e-mobility (4.1 vs. 4.6), shared use mobility (4.3 vs. 4.8) and ESS (4.3 vs. 4.5) on the 5-point Likert scale. However, the ESS usage intention was similar in the two groups (4.3).

Among the local Taiwanese students, usage intention of ESS was high with 80 out of 98 respondents stating agreement (4-5), and 18 neutral or disagreement (1-3) on the 5-point Likert scale (Table 2). Most respondents had previous experience with shared use mobility (83%), mostly bike sharing (76%). The majority had not used an electric vehicle before (64%). Stated trip purposes for potential future trips with ESS (Table 2b) included work/school (28%), shopping (19%) and tourism (16%). When stating with what transport mode such trips are currently undertaken, scooter use was highest (39%), followed by public transport (31%) and walking/bicycling (20%), only 10% stated current car use. While 80% of local students reported the use of only a single transport mode for their current trips, this share was lower among foreigners (63%). While the subsample of foreign students is small, there is a strong indication that mode shifts among that group might take place primarily from public transport to ESS. This is a much higher share than among local students. It is unclear, what causes this difference and further investigation is warranted.

While RF are very similar between both student groups, there are some obvious differences in the RA structure (Figure 1). Locals appear more concerned with a shared scooter's condition (cleanliness/hygiene, maintenance) and driving performance (speed, range). Whereas foreign students more often prefer other transport modes (other preference), and more frequently name safety and weather concerns as RA.

Table 2b　Stated trips for potential future ESS use with purpose and current mode

Local (N=98)	**Trip purpose**		**Trip mode** scoot	car	active	PT	Sum	*
work/school	77	28%	35	2	13	29	79	27%
shopping	52	19%	29	5	10	12	56	19%
leisure	30	13%	12	6	13	7	38	13%
tourism	44	16%	10	11	2	26	49	17%
first/last mile	9	3%	3	0	5	1	9	3%
not coded	60	21%	25	6	17	17	65	22%
	272	100%	114	30	60	92	296	100%
			39%	**10%**	**20%**	**31%**		

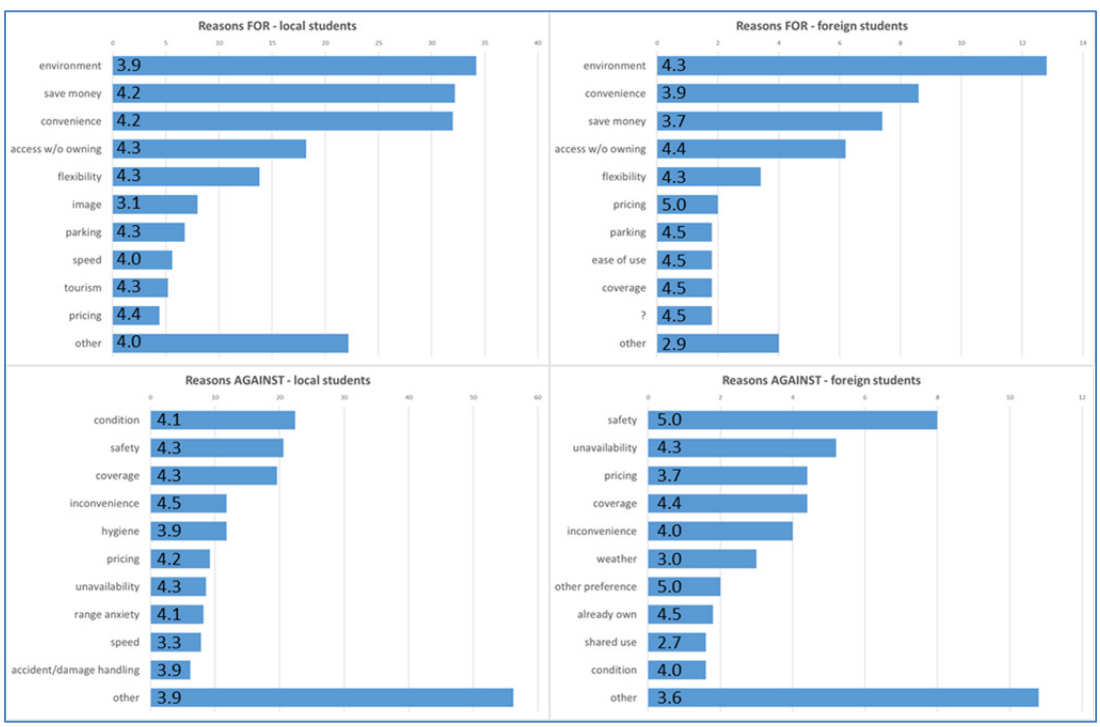
Foreign (N=31)	Trip purpose		Trip mode scoot	car	active	PT	Sum	*
work/school	24	30%	4	2	12	10	28	29%
shopping	16	20%	2	3	12	5	22	22%
leisure	13	15%	1	2	7	7	17	17%
tourism	13	16%	1	1	3	9	14	14%
first/last mile	4	5%	0	0	3	2	5	5%
not coded	11	14%	1	1	5	5	12	12%
	81	100%	9	9	42	38	98	100%
			9%	9%	43%	39%		

"Not coded" trip purposes refer to stated responses like "fun", "environmental protection" etc.

The source of differences found between the two student groups are not always clear. The higher share of scooter trips among Taiwanese students stems most likely from the much higher proliferation of motorcycles in Taiwan. The opposite can be assumed for use or cars and car sharing. Based on the data available, we can only speculate whether differences in the reasoning structure are due to for example cultural differences, transportation habits, or originate from different experiences in different geographic backgrounds. In the remainder of this paper, unless explicitly stated otherwise, our analysis is based on the sample of local Taiwanese students (N=98).

3.2 Reasons for and against

The main purpose of our survey was to explore RF and RA using ESS with the homogeneous sample of local Taiwanese students (N=98). On the code level, stated RF are less diverse than RA. Most stated RF codes are *environment* (58), *convenience* (53), *no need to buy/own* (35), *save money* (32), and *flexibility* (18). The top five RA codes include concerns about a shared scooter's *condition* (cleanliness, maintenance) (32), *distance to next shared ES* (29), *pricing* (22), shared helmet *hygiene* (19) and driving *speed* (15).



Scale: 1 – a little important, 5 – very important.

Figure 1 Top ten stated reasons for and against ESS use and average stated importance (code level)

The analysis of all student's responses to questions about their reasons for and against ESS use resulted in 12 categories. Many students stated RF and RA that were identified as reasons relating to their personal *convenience* (for) or *inconvenience* (against), 68 and 69 respectively. This confirms the high emphasis on personal convenience in vehicle sharing [49]. While "convenience" (53) and "flexibility" (18) dominated the respective RF category, the RA side was more diverse. "Distance to next ES" (29), a perceived general "inconvenience" (13), doubts

about the "availability of ES" (10), and worries about "accidents or damages handling" (11) signify the broad range of topics in this RA category that have been found in car sharing too [50]. Notably, half of the respondents (48) stated (in)convenience simultaneously as RF and RA, while only 18 reported a low ESS usage intention (1-3 on five-point Likert scale). The frequency count in the (in)convenience category is balanced between RF and RA. This highlights the importance of convenience consideration in consumer reasoning. If a certain factor threshold is not reached, e.g. distance to next ES, this may result in a low usage intention.

About three quarters of all respondents (76) related to "*money*" as RF using ESS, while only 22 stated it as RA. The latter uniformly were concerns about "pricing". The majority of those, however, also gave other monetary RF. Among money RF "no need to buy" (35), "save money" (32) and "parking" (14) and "pricing" (11) were most frequently stated. Financial motivations or thriftiness are often associated with shared consumption [51–53], especially by lower income individuals [54].

The single most frequent code was "*environment*" (58) dominating the RF category of the same name (60). Many studies have found environmental benefits to be important motives among car or bike sharing users [52,54]. However, overall findings on this motive as a genuine facilitator are mixed [51].

A pure RA category is "*other preference*" (48) with the most frequent code being "scooter riding is not safe" (24). We decided to subsume this code here as it refers to road safety concerns of scooters in general, rather than to ES or ESS specifically. It therefore indicates a preference for other modes of transport, like car or metro, that have a better safety record. Specific reference to other modes was second, "prefer car/bicycle/bus etc." (9), and "prefer to own scooter" (8) was third. Other RA in this category included references to weather (5) and parking (6).

"Concerns about maintenance, cleanliness" make up the category "*vehicle state*" (32), which together with "*hygiene*" (19) highlights two RA categories that are closely associated with the sharing aspect and well-known in EV sharing [54]. Hygiene concerns almost entirely relate to the shared helmet provided by the ESS operator. On the other hand, "insufficient speed" (15) and "range anxiety" (10) are issues specific to e-mobility. Most responses regarding ESS "*image*" are positive stating it as RF (15), only one as RA.

3.3 Correlation among factors

Bivariate correlations among main categories (Figure 2), attitudes, intentions and current trip purposes confirms some expected relationships. Categories with a count of less than 10 were excluded.

Table 3　Coding categories of reasons for and against ESS use (N=98)

Category	Code	Response Frequency			
		Code		Category	
		RF	RF	RF	RA
Convenience	- (in)convenience	53	13	**68**	**69**
	- distance to next ES (coverage)	5	29		
	- (in)flexibility	18	2		
	- availability of ES	2	10		
	- accident/damage handling		11		
	- charging ES is troublesome		7		
	- other	3	10		
Money	- pricing	11	22	**76**	**22**
	- no need to buy/own	35			
	- save money	32			
	- parking (lower fees, no own parking space etc.)	14			
	- other	3			
Environment	- environment	58		**60**	**2**
	- other	5	2		
Other preference	- scooter riding is not safe		24		**48**
	- prefer car/bicycle/bus etc.		9		
	- prefer to own scooter		8		
	- scooter is bad, when rainy/cold		5		
	- parking is difficult		6		
	- other		6		
Vehicle state	- concerns about maintenance, cleanliness, condition	1	32	**1**	**32**
Performance	- speed of ES considered (in)sufficient	10	15	**11**	**24**
	- range anxiety considerations of ES	1	10		
Hygiene	- concerns about hygiene of shared helmet		19		**19**
Image	- perceived image of ES and ESS	15	2	**15**	**2**
Ease of use	- easy vs. difficult to use	6	2	**6**	**2**
Openness to change	- curious vs. unfamiliar with ES or sharing system	4	3	**4**	**3**
Quietness	- ES is too quiet → dangerous		5		**5**
Privacy	- data privacy concerns		2		**2**
Other	- would use ESS while at tourist destination	6		**8**	**1**
	- other	2	3		

		RF1	RF2	RF3	RF4	RF9	RA1	RA2	RA4	RA5	RA7	RA8	AES	INT	AS	AEA	EE	ES	Sco	Car	Act	PT
		68	*76*	*60*	*11*	*15*	*69*	*22*	*48*	*24*	*32*	*19*					*64*	*90*	*60*	*25*	*43*	*66*
RF1	convenience F				-.325**	-.210*																
RF2	money F			-.227*		-.315**	.294**															
RF3	environment F					.222*		.278**		.307**								.202*			-.280**	
RF4	performance F																					.228*
RF9	image F																					
RA1	convenience A								-.259**													
RA2	money A												.199*		.337**							
RA4	other preference A																-.214*		-.200*			.302**
RA5	performance A																		.260**			-.251*
RA7	vehicle state A																					
RA8	hygiene A																					
AES	Attitude ESS													.753**	.554**	.346**			.266**		-.290**	
INT	Usage intention														.461**	.317**			.218*		-.262**	
AS	Attitude Sharing															.434**					-.265**	
AE	Attitude E-mobility																				-.246*	
EE	Experience E-mobility																	.275**				
ES	Experience Sharing																					
Sco	Scooter																				-.412**	-.448**
Car	Car																					
Act	Active																					
PT	PT																					

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 2　Bivariate Pearson correlations (N=98).

Current modes. Respondents reporting lower scooter use for current trips, less often state other mode preference (RA4) but more often ES performance concerns as RA (RA5). They have in average more positive attitudes toward ESS (AES) and higher usage intentions (INT). Those who currently use active modes (walk/bicycle) state environmental reasons (RF3) less often, and tend to have a less positive attitudes toward sharing (AS), e-mobility (AE) and ESS (AES). In average, they have a lower intention to use ESS (INT). Current users of public transport (PT) tend to view the speed gain of ESS positively (RF4, RA5), but also tend to prefer PT to ESS (RA4).

Attitudes and Intentions. Since each construct's Likert-scale average in this group is based on one question only, results can only be taken as a rough indication. However, they appear to be highly correlated as would be expected based on behavioral theory (AES, INT, AS, AE). Nevertheless, we need to keep in mind that ESS usage intention in our survey may merely represent a general willingness to try it. Our survey did not systematically provide participants with concrete instances of measures of convenience (e.g. average distance to next ES, availability of ES) or a pricing scheme (e.g. minute rate, base fee) which would allow them to make an informed decision based on their reasoning structure. A more detailed analysis employing a sequential equation model or choice theory is beyond this first exploratory step. It would require a broader, more reliable design of the constructs obtained in this study by explorative means.

Reason categories. RA appear clear-cut, with almost no statistically significant correlation among them. In contrast, RF display a number of correlations. Monetary and convenience RF correlate negatively with the other three RF, performance, environment and image. While the positive correlation of the latter two could imply that ESS may carry a positive environmental image that encourages adoption. Respondents stating environmental RF (RF3) however also seem to more often find ESS too expensive (RA2) or consider an e-scooter as too slow (RA5). The only reason category that is correlated (positively) with attitudes is monetary RA (RA2). Respondents who state monetary RA tend to have a more positive view of ESS and sharing in general (AES, AS). Finally, prior experience with shared mobility (ES) seems to instill a perception of ESS as environmentally friendly (RF3). Prior experience with e-mobility (EE) might reduce skepticism toward ESS (RA4).

The reason categories display no direct statistically significant correlation with ESS usage intention. This is not surprising as they are deeper underlying concepts that are unlikely to have a clear direct effect. We would rather suspect indirect path effects through attitudes mediated and/or moderated by individual values, beliefs and experiences. Such structures are suggested by behavioral models based on the assumption of planned behavior [55] or the diffusion of innovation [56], like technology acceptance [57], unified theory of acceptance and use of technology [58] or behavioral reasoning theory [48]. However, testing and confirming such behavioral models requires a different research design than our exploratory purpose commanded.

3.4 Exploratory Factor Analysis

First, we separately explored the grouping structure within RF and within RA. We anticipate such a structure from the correlation results. Again, we only include categories that were mentioned by more than five respondents. In a second analysis, we pool all reason categories to explore grouping structures that overarch RF and RA.

3.4.1 Separate analysis of RF and RA

We took the two-stage approach described in subsection 2.3. Results are shown in Table 4 only for loadings above 0.4. The mostly high loading factors above 0.7 and the dichotomous reason structure in the second EFA stage confirm our qualitative content analysis as reasonable.

During the analysis of RF, the category RF6 *ease-of-use* was not kept. Its inclusion resulted in a separate component, and in a two-component model its communality (variance shared with other categories) was very low (0.028). Communalities for all other factors were above 0.4. From the remaining categories, we extracted two distinct components, which we identified as “eco-is-cool attitude” (component 1 containing RF, RF3, RF9) and “speed orientation” (component 2 containing RF1, RF4). They explain 59% of the total sample variance. The former

comprises a lack of *monetary* reasons, but strong *environmental* and *image* motivations. Similarly, Shaheen et al. [50] pointed out that the environmental concern may be more important among affluent for personal vehicle sharing. The *image* factor in this component emphasizes the relevance of social norms. The latter component is marked by a lack of convenience reasons, but rather emphasizes the instrumental factor *speed* (RF4).

Table 4　Results of 2-staged EFA (N=98).

Stage 1: Reasons FOR	Component	
	1	2
RF1 convenience		-.876
RF2 money	-.600	
RF3 environment	.676	
RF4 performance		.700
RF9 image	.791	
Chi-Sq.= 49.1, df =10		

Stage 1: Reasons AGAINST	Component		
	1	2	3
RA1 inconvenience	.759		
RA2 money		.842	
RA4 other preference	-.788		
RA5 performance			.709
RA7 vehicle state			-.754
RA8 hygiene		-.515	.448
Chi-Sq.= 36.1, df =15			

Stage 2: Components Stage 1	Component	
	1	2
RF comp 1		.843
RF comp 2		-.812
RA comp 1	.419	
RA comp 2	-.782	
RA comp 3	.796	
Chi-Sq.= 40.0, df =10		

Extraction method: Principal component analysis (PCA) with oblique rotation and Kaiser Normalization.

For RA we extracted three distinct components that explain 63% of the variance. All factor communalities were above 0.5. Components were identified as “inconvenience of sharing” (component 1 containing RA1, RA4), “price sensitive” (component 2 containing RA2, RA8) and “E-sharing skepticism” (component 3 containing RA5, RA7, RA8). The first is marked by a lack of *preferences* of other modes or owning (RA4), but by a plethora of reasons regarding a perceived *inconvenience* of ESS (RA1), like distance to nearest ES, or risk of no ES available. The second component represents a perception of ESS as expensive (in RA2), while other downsides of sharing are not present. The third component refers to doubts about to instrumental attributes of ESS, like fears of limited range (in RA5) that is associated with electric vehicles, or the use of a shared helmet that may be considered as unhygienic (RA8).

The dichotomous nature of RF and RA is confirmed in the second stage EFA, where the five components extracted during stage one are analyzed together. However, inconvenience of sharing (RA comp 1) does not load very high on RA and has a low communality (0.185).

3.4.2 Pooled analysis of RF and RA

Respondents were asked about their reasons for and against using ESS, regardless of their actual usage intention. This gives us the opportunity to explore structures and relations between RF and RA. Correlation analysis revealed that such structure likely exist. Therefore, we conducted an EFA with the same six RF (RF1, RF2, RF3, RF4, RF6, RF9) and six RA (RA1, RA2, RA4, RA5, RA7, RA8) pooled together, all with a frequency above five (Table 5). Based on the criteria "eigenvalue > 1" five components were retained. However, inspection of the scree plot led us to a reduced model of only four components, excluding the fifth component with eigenvalue 1.07. There are three reason categories that share few variance with other factors (RA2, RF6, RA8), i.e. communalities lower than 0.4. We excluded RA2 money, but kept RF6 ease-of-use and RA8 hygiene because both load above 0.5 on single components, and offer meaningful interpretation. Typically, one would also exclude factors that load on more than one factor. This is the case for RF2 and RF9, but with different signs. Therefore, we can interpret both factors in meaningful ways and decide to keep them. The resulting model explains 57% of total variance. We extract four distinct components from the pooled analysis, which we identify as the following consumer reasoning types: "Green hypocrisy" (1), "Scooter or Sharing averse" (2), "Tidiness-focused" (3) and "Utilitarian" (4).

Table 5 Results of pooled EFA (N=98).

Reasons	Component				Communalities
FOR and AGAINST	1	2	3	4	
RF1 convenience				-.787	.765
RF2 money		-.527		.484	.720
RF3 environment	.779				.620
RF4 performance				.710	.576
RF6 ease of use		.539			.374
RF9 image	.417		-.707		.706
RA1 convenience		-.729			.565
RA4 other preference		.635			.518
RA5 performance	.685				.506
RA7 vehicle state			-.664		.540
RA8 hygiene			.523		.373
Chi-Sq.= 134.4, df =55					

Extraction method: Principal component analysis (PCA) with oblique rotation and Kaiser Normalization.

Hypocrisy means having a general attitude without implementing the corresponding behavior [59]. People aligned with *green hypocrisy* (component 1) tend to give environmental RF for using ESS (RF3), while also caring about their own projected image when doing so (RF9). In addition, sufficiently high speed (RA5) is important to them. Environmentalism for this type is an abstract norm that makes moral hypocrisy quite likely under circumstances where hedonic or gain motives will lead to self-serving outcomes [60]. Numerous studies have investigated this inconsistency between attitudes and behavior of people [61–64]. It is referred to as the attitude-behavior gap (also value-action gap) and particularly present when it comes to environmental issues [65]. In our context, it might be questionable whether the perceived environmental advantages actually affect ESS adoption positively, because they might be offset by an ES performance considered insufficient (RA5 speed and range of the individual motorized vehicle). In other words, most people might agree that the environment needs protection, but when it comes to concrete action there may be insufficient readiness/willingness to compromise on habits or standards of living. Despite the mostly positive usage intentions found in our study, we have no information an actual behavior. Therefore, whether green hypocrisy is indeed present in the ESS context yet requires confirmation.

The second type is *scooter-* or *sharing-averse* (component 2). For the former, money and convenience may play minor roles. Even if consumers perceive ESS as easy to use, other modes of transport may be preferred due to road safety concerns or a preference for public transport. Inversely, *sharing-averse* acknowledges the potential monetary savings, but considers the convenience lost when using shared mobility as an important RA. Shaheen et al. [50] identified a "fear of sharing" among the most common barriers to the adoption of personal vehicle sharing. Others found that some consumers groups display a clear aversion to new car sharing modes [66].

The *tidiness-focused* (component 3) group cares much about the image it projects by using ESS, which naturally is closely related to the appearance of the ES (cleanliness, state of repair). These have been found relevant factors in car sharing [54]. Alternatively, hygiene concerns about sharing a helmet can become a paramount RA, if not addressed by the operator. This is a barrier not present in other sharing modes, including bike sharing where usually the law does not require wearing a helmet.

Finally, the *utilitarian* type (component 4) is made up solely of RF. Either there is a strong convenience orientation (RF1), or an emphasis on monetary savings (RF2) and speed requirements (RF4). It implies a mutual exclusiveness of the former and the latter. The reasons for this are not clear, and may be specific to our sample.

3.5 Binary Logit Model

The analysis of bivariate correlations discussed in subsection 3.3 did not allow us to look at

several factors that influence ESS usage intention simultaneously. In addition, we cannot assume that the differences on the 5-point Likert scale are proportional. Therefore, we use a dependent variable takes a value of one when the stated ESS usage intention was high (4-5), and a value of zero otherwise (1-3) on the five-point Likert scale. We include both student groups (local and foreign) in this analysis (N=129) as we can differentiate the effects of independent variables by using dummy variables and interactions. In case of a dichotomous dependent variable, binary logit regression is appropriate. Collinearity diagnostic for the variables included in the final model is negative.

We expect to find that respondents' experience with electric mobility [67–69], shared mobility, and their current mode choices [54,70] for potential ESS trips influence their ESS usage intention . We do not expect to find significant influence from among the reason categories formed during QCA or of the components extracted during EFA. As discussed at the end of subsection 3.3, these are underlying latent constructs that need to be tested under a different research design. However, ESS usage intention is generally high in our sample (80%) and some reason categories (convenience, money, environment) were stated by most participants (Table 3). Hence, some statistical correlation with the chosen dependent variable is likely.

Table 6 shows the results of the logit regression. In both student groups, current scooter use and previous e-bike experience appear to have a notable influence on their ESS usage intention. The former variable could take values between zero and three, depending on how many reported trips are currently undertaken by scooter. Over half the respondents stated such trips (one trip: 23, two trips: 26, three trips: 16). The more scooter trips the higher their ESS usage intention. Experience with electric bicycles seemed to moderate usage intention in our sample with 17% of respondents reporting it, which could be related to its association with RA4 "other preference". This might indicate a dislike for the scooter mode and consequently ESS.

While among foreign students, a promoting effect of prior experience with shared mobility (e.g. car or bike sharing) on ESS usage intention is obvious. The same cannot be said about local students, where bike sharing experience appears to have a negative influence. Efthymiou et al. [70] found that bike sharing tends to attract more people that otherwise walk, while car sharing attracts those that use public transport for their commute. In our local students' sample, bike sharing experience is positively correlated with sustainable trip modes (walk, bicycle, public transport – TPM3, TPM4), and negatively correlated with scooter and car use (TPM2, TPM2). It is possible that it represents the kind of "scooter averseness" we identified from our pooled EFA (subsection 3.4).

Table 6　Results of Logit regression (N=127).

Dep.var. : High ESS usage intention	Coef.	Std. Err.	z-value	p-value	[95% Conf. Interval]	
Current mode: scooter (0/1/2/3)	0.794	0.307	2.59	0.010	0.192	1.395
E-bike experience (0/1)	-1.218	0.632	-1.93	0.054	-2.456	0.021
Local x bike sharing experience (0/1)	-1.053	0.563	-1.87	0.062	-2.158	0.051
Foreign x sharing experience (0/1)	2.421	1.281	1.89	0.059	4.931	0.090
_cons	1.838	0.499	3.68	0.000	0.859	2.816

Chi2(4) =18.5, Prob > chi2 = 0.001, Log likelihood = -53.741, Pseudo R2 = 0.1469

Note: Two observations dropped due to missing values in current trip mode.

IV. Concluding Remarks

Our analysis and discussion in this paper is based on a survey conducted among a group of Taiwanese and foreign university students, who studied transportation related courses. We employed quantitative and qualitative methods to analyze the data, thereby extracting factors influencing the participants' intention to use ESS. Among those factors are the ones we expected from car or bike sharing, but also others that appear to be more specific to ESS. We confirmed the dichotomous nature of RF and RA with regard to ESS, but also identified grouping structures across the for-against divide. The latter sheds light on the intricacies of consumer reasoning in this context.

Although the small sub-sample of foreign students is small, it is obvious that despite many commonalities there are important differences to the reasons stated by local students. These refer also to current mode choices and mobility experiences. This encourage further research exploring the why and how these differences arise.

A compelling result of the survey is the wide range of RA stated by respondents compared to RF. Consumer's RF and RA using ESS display different structures and emphasis. This suggests that they should be investigated in distinction, in order to better understand the motives for using or not using ESS. In order to achieve large-scale adoption, ESS operators seemingly need to address a wide range of potential adoption barriers. Further analysis is needed to investigate the effect of barriers (e.g. hygiene, image) that become effective even in the presence of strong facilitators (financial saving). The simultaneous influence of possible moderating (experience, travel behavior) or mediating factors (attitudes, norms, beliefs) needs to be considered.

Our results suggest a marketing focus on convenience gains and monetary advantages compared to ownership. Combined with building or highlighting a positive ecological image of

ESS this could reach important target groups that stated a supportive attitude toward ESS. However, careful pricing is necessary; otherwise, potential user groups could be shut out. Given our sample of (presumably) frugal university students, price differentiation could be an appropriate measure.

Because of our research focus, the sample of university students is not representative for the larger population of Taiwan. It is also not representative for Taiwanese university students in general, because students of different faculties often have different attitudes and personalities that influence their travel behavior [71].

In our sample, a considerable share of trips that ESS could potentially replace trips currently undertaken with more environmentally friendly modes (walk, bicycle, public transport). Replacing them with individual motorized transport may be concerning to policy makers and environmental protection agencies. Strategies to mitigate this effect may be desirable and necessary.

Taken in combination, our findings create a basis for the development of new survey instruments to investigate consumer behavior regarding the relatively new ESS mode.

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