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Facilities and Service Models for Electric Scooter Recharge Stations

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ABSTRACT: *Increasing the prevalence of electric scooters (e-scooters) is difficult because recharge stations are inconvenient and charging is time consuming; therefore, establishing convenient and user-friendly e-scooter recharge stations is essential. Between 2009 and 2012, the Taiwanese Ministry of Economic Affairs (MOEA) offered subsidies to individual users who bought e-scooters equipped with portable lithium-ion cells and to the manufacturers who established qualified charging devices. Consequently, sound planning for managerial models is imperative. This study explores innovative service models of e-scooter recharge stations, and proposes new prospects as well. An expert interview questionnaire was designed based on a literature review and interview analyses. Expert questionnaires are collected and analyzed, consisting of three dimensions: (a) facilities and service models, (b) establishment and promotion of e-scooter recharge stations, and (c) innovative e-scooter recharge stations e-service models. According to the professors' and professional managers' academic and practical opinions, we identify the model of establishing recharge stations at convenience stores and large supermarkets and department stores as the most feasible options. Moreover, most experts identified that cell-exchange stations also help in developing the e-scooter industry as well. Regarding innovative service models, the automatic model is the future trend.*

KEYWORDS: *E-scooter Recharge Station, E-service Model, Expert Questionnaire.*

1. Motivation

The air quality in Taiwan is low. The considerable number of motorcycles, which is the result of urban overpopulation, causes severe air pollution. Therefore, promoting eco-friendly e-scooters is crucial. According to the statistics compiled by the Ministry of Transportation and Communications, motorcycles, which are prevalent, totaling 14 million in 2008, produce not only a considerable amount of noise and pollution but also cause severe damage to people's quality of life in cities. Consequently, reducing air pollution by promoting e-scooters is vital. However, riders who are accustomed to riding motorcycles are reluctant to buy e-scooters, despite the promotion of e-scooters in the past few years, because buying and maintaining e-scooters is inconvenient and cell charging is time consuming. In addition, e-scooters have low durability, and potential e-scooter buyers have motorcycles.

E-scooter users lack conveniently located recharge stations and charging power cells is extremely time-consuming. Therefore, making recharge stations available at locations frequently visited by e-scooter users, such as scenic spots, shopping areas, schools and offices, and even near residences, is necessary. In addition to the subsidies for e-scooter purchases, the availability of public and private e-scooter recharge stations is the most effective incentive.

However, the central government subsidies for e-scooters were suspended in 2003, causing the recharge stations to become idle, except for the stations in Changhua County. At that time, seven types of recharge locations were available: district offices, borough offices, city councils, schools, mass rapid transport stations, motorcycle shops, and gas stations. The subsidies offered by the Industrial Development Bureau (IDB) of the Ministry of Economic Affairs (MOEA), which were expected to foster substantial growth of the e-scooter market, were last made available to the public on July 1, 2009.

In summary, the availability of adequate infrastructure and resultant services to enhance the users' motivation to buy e-scooters is critical. The previous model failed to actualize the mentioned infrastructure; consequently, the public and private sectors are offering new service models to increase the prevalence of e-scooters and the prospective development of business opportunities in neighborhoods for e-scooter charging.

2. Literature review

2.1 E-Scooter and recharge station policy review

Taiwan's central government seeks to build a sound industrial cycle for e-scooters by developing essential technologies. This is demonstrated in the central government's promotion of e-scooters through policies including Challenge 2008: National Development Plan. This e-scooter promotion plan was developed by the IDB and MOEA, which is scheduled to begin providing subsidies to e-scooter buyers at the end of 2013. The plan was approved in September 2010 by the Executive Yuan. Subsequently, the IDB promulgated the Guideline of Subsidies for E-scooter Buyers, the Standards for Authorized Inspection of E-scooters, the Standards for E-scooter Function and Safety Testing, and the Guideline of Subsidy and Encouragement for E-scooter Development. In addition, the qualified e-scooters' power source was the MOEA-stipulated portable lithium-ion cells; however, the subsidies were given to those who received the approval of the Executive Yuan. Consequently, the e-scooters that were powered by lead acid batteries were no longer needed.

Several developmental strategies have been implemented. Vendors, in association with the local and central government, are assisted in promoting and building infrastructure for e-scooter users, including charging and cell exchange stations. In addition, the vendors collaborate with various e-scooter associations and an R&D alliance responsible for integrating the R&D of key technologies. The other main strategies include establishing standards for the interfaces of crucial parts for low-cost R&D and convenient maintenance, quality and safety standards for the relevant products, an adequate environment for testing, and e-scooter information exchange platforms to promote and introduce e-scooters (Yang, 2005).

2.2 Current status of the service model

The advanced development of battery cells makes lithium-ion cells the principal power source for e-scooters because they are convenient, light weight, long lasting (Lin & Sun, 2007), and allow users to receive subsidies. However, taking adequate measures, such as establishing conveniently located recharge stations, may encourage potential buyers to purchase e-scooters instead motorcycles. New e-scooter recharge stations must be appropriately planed, because those built in the 2000s are rarely used. Several service models for scooter recharge stations in Taiwan are outlined in the following sections.

(1) Plug chargers

The free recharge stations that county and city environmental protection bureaus built to comply with the Action Plan for E-scooter Development 1999 became the model for contemporary policies. The subsidies were suspended in 2003 and the low number of e-scooters caused the recharge stations to become idle; they are no longer in use, except in Changhua County.

(2) Coin-slot chargers

Coin-slot chargers are available in some parts of Nantou County; they are equipped with voice reminders, timer displays, and modules to show the cell voltage. This rapid charging device can charge two sets of cells in 2 hours at a cost of NT$5.

An excessive number of motorcycles are used in Taiwan; therefore, dedicating extensive efforts to e-scooter development is crucial. Because e-vehicles are being adopted worldwide, the recharge stations overseas are designed and built principally for e-vehicles. Yet, the service models used abroad can serve as a reference.

2.3 Service model for offshore islands

A study on the planning of e-scooter charging devices in the Penghu area by Wang, Kang and Yang (2002) indicates that e-scooter users are required to spend long periods charging at scenic spots to complete long routes because of the low endurance of e-scooters and the low efficacy of lead acid batteries. Lin (2007) concluded that recreational e-scooters might be charged at scenic spots because users could enjoy the scenery while they complete long routes. He identified the need to build e-scooter recharge stations at scenic spots for e-scooter users' convenience, which can enable users to enjoy a short cell-charging time and a long sightseeing time.

In the Penghu area, recharge stations are considered a substitute of power supply, ensuring that e-scooter users can complete long sightseeing routes by using a sufficient number of e-scooter recharge stations and the limited endurance of e-scooter cells are addressed without financial waste (Wang, 2008b). The establishment of recreational e-scooter recharge stations on offshore islands is considered to initiate the founding of recharge stations in other areas. Both lease administrators and citizens might be willing to buy e-scooters because of the uniform specifications of cells and the availability of e-scooters on offshore islands. The use of e-scooters can be encouraged by installing automated recharge stations and cell exchange services (Wang, 2008a).

2.4 Prospects for recharge stations

Formulating a sound e-scooter recharge station model is necessary, and the state must promote the use of e-scooters. Therefore, we offer the following proposals:

First, the central government is advised to repair and maintain all the recharge stations built in the 2000s throughout Taiwan and enhance the stations with conditions that are adequate for expansion (Raper, Gartner, Karimi & Rizos, 2007). Additional recharge stations must be established to extend their availability to e-scooter users.

Second, it is feasible to collaborate with transport infrastructure bodies, such as the Taiwan Railway, Taiwan High Speed Rail, and Taipei and Kaohsiung Rapid Transit Corporations, in developing parking and compound e-scooter recharge stations to encourage travelers to access mass transportation by using personal e-scooters.

Third, it is possible to cooperate with private enterprises such as 7-11 (a convenience store chain), Carrefour (a large supermarket chain), and Far Eastern (a department store chain) in establishing small urban chargers to attract citizens to buy and use e-scooters when shopping.

Finally, the central government could stipulate the standard specifications of portable lithium-ion cells that are used by e-scooter manufacturers (Fu, 2008). Therefore, building recharge stations is unnecessary, and replaceable cells can be offered to users in remote areas (Peng, 2010). This approach, which was submitted at the first Low Carbon Expo held by Taipei County in October 2009, prevents time-consuming charging and offers substantial availability and feasibility.

Thus, establishing cells exchange stations is also feasible. The criteria required to realize them are (1) standardized cells; (2) anti-theft functions; (3) compliance with the Taiwan e-scooter (TES) certification program; (4) accordance with users' habits; (5) quality and safety; (6) carefree cells; and (7) fees that are lower than the price of gasoline.

2.5 E-applications for recharge stations

According to expert opinion, a converted point of sale (POS) can be used to display the charging status at recharge stations to assist statistical analyses by employing (1) RFID-tagged rechargeable cells and RFID readers to replace optical scanners and barcodes; (2) the information management system's auto-tellers, which enable users to monitor their usage of the cells and pay by using e-currency or cash while charging (Pousttchi, 2008); and (3) a pre-paid card like Easycard, which can enable e-scooter riders to add value and obtain e-scooter maintenance information at the stations (Herzberg, 2003). In addition, POS use allows administrators to analyze data and administration figures and formulate relevant marketing strategies.

Global economic growth and change alter the academic and practical perspective of innovative service (Doganova & Eyquem-Renault, 2009). An innovative service model outlined by Tang, Tsai and Wang (2009) suggests that formulating and proposing innovative services regarding organizational administration and position is necessary. Tang et al. (2009) also identified the process of resource coordination and use, integration across networks, and value adding as influential factors. Consequently, the items concerning the innovative facilities and service models of e-scooter recharge stations in the expert questionnaires were compiled using academic and practical experts' opinions and by considering the interviews and literature review from the perspectives of consumers and administrators.

3. Methodology

In this study, we designed questionnaires, interviewing experts regarding eight innovative recharge station service models, to obtain adequate academic and industrial views. The questionnaire results were subsequently analyzed and discussed, and key models were proposed. The group of interviewed experts comprised people familiar with innovative green energy service models including two engineering experts, two business administration experts, and one expert on the integration of manufacturing and commerce. The interviews were conducted according to predetermined schedules and procedures that were determined based on the objects of this study.

The experts suggested that future recharge stations include automated machines, which should be equipped with the Internet, information technology, and automatic devices to provide consumers with prospective and innovative services, once the software (managerial) and hardware (technical) obstacles are overcome. That is, consumers can use the charging system in a convenient and self-reliant manner. In addition, cell exchange stations could be located at recharge stations or automated stores which combine some elements: self service retail, information technology and unique vending machines and the automated convenience store.

The continuous development of technology renders new service models of e-scooter recharge stations necessary; therefore, the applicability of these models was evaluated using the expert questionnaires. Six university professors who specialized in business intelligence (BI), artificial intelligence (AI), software engineering (SE), RFID, data mining, management of technology (MOT), and management of information systems (MIS) and seven professional managers who specialized in R&D, marketing, industry analysis, business automation, digital content, and innovative service models completed the expert questionnaire. Their personal perspectives regarding e-scooter recharge stations and associated factors, as well as the adequacy and value of the related dimensions and items, were collected and presented in Table 1.

Following the experts' suggestions, the content and applicability of Dimensions 1-3 were evaluated using content validity (Lawshe, 1975), and the results were provided.

Table 1 Dimensions and Items

Dimension	Sub-dimensions	Items
1. Facilities and service models	1. At automated stores 2. At convenient stores, large marts and shopping centers 3. At repairing and maintaining places 4. At parking lots of stations 5. At large leisure facilities 6. At large urban parking lot 7. At streets and cell exchange stations	Industry prevalence and development Technical applicability User-friendly Innovative values of commerce Business chances of neighboring industries
2. Installation and promotion	1. Location concerns 2. Promotional manners	Helpful to e-scooters promotion Ranking of promotional manners Models at offshore and sightseeing areas Queries of locations
3. Innovative service models	1. Information display 2. Mobile commerce 3. Maintenance information system	Issues on demand Issues on management Issues on technology

3.1 Reliability

Reliability analysis was conducted to measure the consistency and stability of test results, specifically, the internal consistency, for which high correlation levels indicate high reliability levels. Holsti's (1969) equation was used to test the reliability of the questionnaires. Three questionnaires completed by the university professors and professional managers were selected to verify the reliability of the academic and industrial experts for subsequent analysis, Three questionnaires completed by the university professors and professional managers were selected to verify the reliability of the academic and industrial experts for subsequent analysis (Wang, 1989), which is presented in Table 2. The equation is as follows:

Inter-rater agreement = 2M/(N1 + N2)

M: Total number of variants with the identical reply of two raters

N1: Variants' total for Rater 1

N2: Variants' total for Rater 2

Reliability Coefficient = n × (means of inter-rater agreement)/1 + [(n-1)] × (average inter-rater agreement)

n: Total number of raters

Table 2 Reliability Analysis

Managers	Managers 1 & 2	Managers 2 & 3	Managers 1 & 3
Agreement	0.71	0.79	0.69
Professors	Professors 1 & 2	Professors 2 & 3	Professors 1 & 3
Agreement	0.71	0.78	0.70

The reliability coefficients of 89% were acceptable because both exceeded 85%, which represents the level of statistical acceptance recommended by Kassarjian (1997).

The equations of the professional managers' inter-rater agreement and reliability coefficient were the following:

$(0.71 + 0.79 + 0.69)/3 = 0.73$ and $3 * 0.73/\{1 + [(3-1) * 0.73]\} = 89\%$

The equations of the professors' inter-rater agreement and reliability coefficient were the following:

$(0.71 + 0.78 + 0.70) / 3 = 0.73$ and $3 * 0.73 / \{1 + [(3-1) \times 0.73]\} = 89\%$

3.2 Validity

Validity, which is also known as accuracy, indicates the extent to which a scale can authentically measure the content it is intended to measure; a scale that cannot meet this precondition is invalid. Content validity refers to the degree to which the items of all the measured constructs can be represented on a scale. Because of the subjective testing of content validity, experts are commonly requested to determine the content validity of a scale.

First, the selected experts selected were asked to complete questionnaires within a specific time and return them by email for collation and analysis. Later, statistical procedures were applied to the number of questionnaires that were delivered, the number of valid questionnaires, the retrieval rate, and the type of experts. The items were encoded (the importance was encoded on a scale from 1 to 5, where 1 and 5 refer to the least and the most critical scores, respectively).

In Table 3, the content validity ratio (CVR) is used to eliminate inadequate items; therefore, an item that cannot meet the least required value is deleted. According to Lawshe (1975), the least value is 54%. We delivered and retrieved 13 valid questionnaires. We employed a 5-point Likert scale with the points as the baseline; therefore, items below the baseline were deleted. However, the CVR fails to explain and represent the authentic significance of the content validity because of the negative values of indicators and the narrowly defined consistency of the assessed standards, despite the compliance with the content validity of each item.

Table 3 CVR Requirements of Experts' Number and Least Value

Experts' number	CVR least value
3	1
5	0.99
7	0.99
8	0.75
10	0.62
20	0.42
25	0.37
30	0.33

3.3 Results analysis

Tables 4-6 present the items retained and excluded.

Table 4 Items Deleted under Significant Levels

Facilities and service models	Item
Automated stores	• Technical applicability of founding • User-friendliness and prevalence • Business innovation • Business chances
Repairing and maintaining places	• Technical applicability of founding • Business innovation • Business chances
Parking lots of stations	• Technical applicability of founding • Business chances
Innovative service model	**Item**
Maintenance information system	• A technician required at the station

Table 5 Items Excluded via CVR

Dimension		Item		CVR of professors	CVR of managers	CVR of all
I Facilities and service models	1	1-1 Automated stores	1-1-2 Technical applicability of founding	0.33	0.43	0.38
			1-1-3 User friendliness and prevalence of e-scooters	0.33	0.14	0.23
			1-1-4 Business innovation of stations	0.33	0.43	0.38
			1-1-5 Business chances of neighboring areas	0.33	0.14	0.23
		1-3 Repair and maintenance centers	1-3-2 Technical applicability of founding	0.33	0.14	0.23
			1-3-4 Business innovation of stations	0.00	0.43	0.23
			1-3-5 Business chances of neighboring areas	0.00	0.71	0.38
		1-4 Parking lots of stations	1-4-2 Technical applicability of founding	0.67	0.14	0.38
			1-4-5 Business chances of neighboring areas	0.33	0.43	0.38
III Innovative e-scooter recharge station service models	3	3-1 Maintenance information system	3-1-3-b A technician must remain at the station to provide maintenance	0.33	0.14	0.23

Table 6 Items Kept via CVR

Dimension		Item		CVR of professors	CVR of managers	CVR of all
I Facilities and service models	1	1-1 Automated stores	1-1-1 Prevalence and development of stations	0.33	0.71	0.54
		1-2 Convenient stores, large marts and shopping centers	1-2-1 Prevalence and development of stations	1.00	1.00	1.00
			1-2-2 Technical applicability of founding	1.00	0.71	0.85
			1-2-3 User friendliness and prevalence of e-scooters	1.00	1.00	1.00
			1-2-4 Business innovation of stations	1.00	0.71	0.85
			1-2-5 Business chances of neighboring areas	1.00	0.71	0.85
		1-3 Repair and maintenance centers	1-3-1 Prevalence and development of stations	0.67	0.43	0.54
			1-3-3 User friendliness and prevalence of e-scooters	0.33	1.00	0.69
		1-4 Parking lots of stations	1-4-1 Prevalence and development of stations	0.67	0.43	0.54
			1-4-3 User friendliness and prevalence of e-scooters	0.67	0.71	0.69
			1-4-4 Business innovation of stations	0.67	0.43	0.54
		1-5 Large leisure facilities	1-5-1 Prevalence and development of stations	0.67	0.71	0.69
			1-5-2 Technical applicability of founding	0.67	0.43	0.54
			1-5-3 User friendliness and prevalence of e-scooters	0.67	0.43	0.54
			1-5-4 Business innovation of stations	0.67	0.71	0.69
			1-5-5 Business chances of neighboring areas	0.67	0.71	0.69
		1-6 Large urban parking lots	1-6-1 Prevalence and development of stations	0.67	1.00	0.85
			1-6-2 Technical applicability of founding	0.67	0.43	0.54
			1-6-3 User friendliness and prevalence of e-scooters	0.67	0.71	0.69
			1-6-4 Business innovation of stations	0.67	1.00	0.85
			1-6-5 Business chances of neighboring areas	0.33	0.71	0.54

Table 6 Items Kept via CVR (continued)

Dimension	Item		CVR of professors	CVR of managers	CVR of all
	1-7 Streets	1-7-1 Prevalence and development of stations	1.00	0.71	0.85
		1-7-2 Technical applicability of founding	1.00	1.00	1.00
		1-7-3 User friendliness and prevalence of e-scooters	1.00	0.71	0.85
		1-7-4 Business innovation of stations	0.33	1.00	0.69
		1-7-5 Business chances of neighboring areas	0.33	0.71	0.54
II Establishing and promotinge-scooter recharge stations	2. Is the cell exchange station applicable in addition to the preceding 7 models?		1.00	1.00	1.00
	2-1 Founding e-scooters recharge stations helps promote the e-scooters and e-scooters industry		1.00	0.71	0.85
	2-3 Offshore and sightseeing model	2-3-1 E-scooters as a main transport tool in offshore and sightseeing areas	0.67	0.71	0.69
		2-3-2 E-scooters recharge stations at scenic spots as the main concern	0.67	1.00	0.85
		2-3-3 E-scooters recharge stations founded in offshore area help promote those in others	0.67	0.43	0.54
	2-4 Location queries	2-4-1 Querying stations by the internet	1.00	1.00	1.00
		2-4-2 Query stations which are at the key scenic spots and land marks	0.67	0.71	0.69
		2-4-3 Necessity to query the GPS of the stations	1.00	0.71	0.85

Table 6 Items Kept via CVR (continued)

Dimension			Item	CVR of professors	CVR of managers	CVR of all
III Innovative e-scooter recharge station service models	3-1 System requirements	3-1-1 Information display	3-1-1-a Necessity to display the cell status	1.00	1.00	1.00
			3-1-1-b Displaying the endurance available and the nearest station	1.00	1.00	1.00
			3-1-1-c Querying station locations using the system	1.00	1.00	1.00
		3-1-2 Mobile commerce	3-1-2-a Ability to access the homepage by using QR codes for information and discounts available over the phone	0.67	1.00	0.85
			3-1-2-b Ability to query the nearest stations and discounts by mobile phones	0.67	1.00	0.85
		3-1-3 Maintenance information system	3-1-3-a Finding the breakdown alarm system of chargers	1.00	1.00	1.00
	3-3 Technology feasibility	3-3-1 Cashiers	3-3-1-a Feasibility of cash paid by POS after charging	1.00	1.00	1.00
			3-3-1-b Feasibility of payment paid by the prepaid RFID card with value adding by POS after integrating e-wallet and RFID, e.g. Easycard and iCash	1.00	1.00	1.00

3.3.1 Dimension I: Facilities and service models

1-1 Automated stores

1-1-1 The significance of the item (prevalence and development of stations) and other items were excluded because of the lack of development and regulations at automated stores, namely, preventive measures against purposeful damage, management during charging, and no standard prices of charging.

1-2 Convenience stores, large marts and shopping centers

All items reaching the significant level were retained; the professors and professional managers specifically approved Items 1-2-1 and 1-2-3.

1-3 Repair and maintenance centers

The retention of items 1-3-1 and 1-3-3 demonstrates their consistency and approval, whereas the other items were deleted because of the relatively high cost of e-scooters and their low prevalence

1-4 Parking lots of stations

Items 1-4-1, 1-4-3 and 1-4-4 were retained, although the professional managers disapproved and the professors approved Items 1-4-1 and 1-4-4. The Items 1-4-2 and 1-4-5, which scored below the significance level, were deleted because of the immature e-scooter market, despite the intensive promotion, abundant purchase subsidies, and exclusive parking lots.

1-5 Large leisure facilities

All items reaching the significance level were retained, although the professional managers disapproved but the professors approved Items 1-5-1 and 1-5-3.

1-6 Large urban parking lots

All items reaching the significance level were retained because the professional managers approved Items 1-6-1 and 1-6-4 and disapproved Item 1-6-2, and the professors disapproved Item 1-6-5.

1-7 Streets

All items were retained because all experts approved Item 1-7-2. Yet, the professors approved Items 1-7-1 and 1-7-3 and disapproved Items 1-7-4, whereas the professional managers approved Items 1-7-4.

2 Cell exchange stations

The consistent agreement of all experts on this option shows its feasibility.

The option of having a technician at each station is below the significance level because of its high cost, low concern, and the small and immature e-scooter market.

3.3.2 Dimension II: Installation and promotion of e-scooter recharge stations

2-1 Establishing recharge stations promotes e-scooters and the e-scooter industry
This item was consistently scored and approved by of all of the experts.

2-3 Offshore and sightseeing model
All items were retained; Item 2-3-2 gained especially high approval.

2-4 Location queries
All the items that reached the significance level were retained, and Item 2-4-1 was approved by all of the experts. Item 2-4-3 was approved by all of the professors.

3.3.3 Dimension III: Innovative service models of e-scooter recharge stations

3-1-1 Information display
All items reaching the significance level were retained, which indicates their consistency and necessity.

3-1-2 Mobile commerce
All items reaching the significance level were retained, indicating their consistency and necessity. These items received high CVR values from the professional managers.

3-1-3 Maintenance information system
Item 3-1-3-a, which reached the significance level, was retained, and 3-1-3-b, which did not reach the significance level, was deleted.

3-3-1 Cashiers
All items reaching the significance level were retained because they received the approval of all the experts.

4. Discussions

4.1 Dimension I: Facilities and service models

The most highly rated option was 1-2, which entails establishing recharge stations at convenience stores, large supermarkets, and shopping centers; 84% of the experts approved the cell exchange stations project. The following locations were also recommended: (1) campuses and scenic spots; (2) community parking lots inside buildings; (3) gasoline stations; and (4) solar cells equipped for e-scooter recharging.

4.2 Dimension II: Installation and promotion of e-scooter recharge stations

A consent ratio exceeding 80% indicates the need for establishing and promoting e-scooter recharge stations. Two distinct opinions were expressed for Item 2-2 (promotional methods and sequence): (1) establishing e-scooter recharge stations on offshore islands and sightseeing areas on Taiwan Island before promoting them in other places; or (2) establishing recharge stations in centralized areas, such as towns, before promoting them in sightseeing and offshore areas. Item 2-3-1, which was the option of promoting e-scooters as a principal means of transport in offshore and sightseeing areas, received substantial positive replies; however, a 46% rate that included replies such as "no comment," "disagree," and "strongly disagree" is cause for concern.

All items belonging to Item 2-4 (Location queries) obtained considerable approval despite the deliberation on Item 2-4-3 (necessity to query the GPS of the stations). In addition, the alternative professional managers' views on establishing e-scooter stations and the promotion of the widespread use of e-scooters are summarized as follows:

"Despite the recognized demand and necessity of establishing e-scooter recharge stations and cell-exchange stations, the requirement of cell-exchange stations depends on the total quantities of e-scooters that require an authentic commitment from the central government to promote e-scooter-related industries. Consequently, highly polluting motorcycles should be legally banned and a policy for establishing recharge and cell exchange stations should be progressively instituted. Motorcycles must be periodically tested to determine whether they should be withdrawn from circulation; however, this cannot directly increase the number of e-scooter users. The central government's policy for e-scooter promotion should involve subsidizing e-bikes first and, subsequently, e-scooters."

Despite the recognized demand and necessity of establishing e-scooter recharge stations and cell-exchange stations, the requirement of cell-exchange stations depends on the total quantities of e-scooters that require an authentic commitment from the central government to promote e-scooter-related industries. Consequently, highly polluting motorcycles should be legally banned and a policy for establishing recharge and cell exchange stations should be progressively instituted. Motorcycles must be periodically tested to determine whether they should be withdrawn from circulation; however, this cannot directly increase the number of e-scooter users. The central government's policy for e-scooter promotion should involve subsidizing e-bikes first and, subsequently, e-scooters.

4.3 Dimension III: Innovative service models of e-scooter recharge stations

However, Barnes (2002) identified the potential of mobile commerce based on the popularity of mobile technologies such as smart phones.

Items 3-1-1-a (Displaying the cell status), 3-1-1-b (Displaying the endurance available and the nearest station), and 3-1-1-c (Querying station locations using the system) received positive responses, despite the inconsistency regarding cell durability, which is an example of the technical obstacles that must be overcome. Furthermore, standardizing cell exchange is desirable.

Items 3-1-2-a (Ability to access the homepage by using QR codes for information and discounts available over the phone) and 3-1-2-b (Ability to query the nearest stations and discounts by mobile phones) received positive responses, despite a level of uncertainty. However, Barnes (2002) identified the potential of mobile commerce based on the popularity of mobile technologies such as smart phones. In addition, numerous handset functions and advanced mobile telecommunication technology (3G/3.5G) gave rise to GPS queries and individualized services.

Items 3-2-1-b (credit card) and 3-2-1-c (e-wallet) were internally consistent because automated recharge stations could become future trends. Items 3-2-2-a (automated recharge stations) and 3-2-2-c (cooperate with nearby stores) were also internally consistent.

Item 3-3-1-a (feasibility of cash payments at the POS), which received an equal percentage of agreement and no comment is not desirable; conversely, Item 3-3-1-b (feasibility of using prepaid RFID cards) received a positive response. In Taiwan, people who hold prepaid cards, namely, Taipei Easycard, Taichung e-Card, and Kaohsiung I Pass, are considerably increasing in number, especially those using Easycard. The total number of issued cards exceeded 15 million in 2008. In addition, the Act Governing the Issuance of Electronic Stored Value Cards approved by the Legislative Yuan in 2009 allows small payments to be made by using prepaid RFID cards as a mainstream practice.

5. Conclusion and suggestions

Academics focus on the construction and application of intelligent environments, namely, campuses, mass transport systems, shopping spaces, workplaces, and individual residences. Offering optimal services to users by introducing intelligent environments that apply to e-scooter recharge stations is possible. However, identifying the status and prospects of service models for the e-scooter recharge station market is crucial because the unidentifiable market demands and the temporary industrial value chains for validly promotion of the widespread adoption of e-scooters by using sound information services through the professional views concerned.

Regarding the analyzed data, the experts identified the model for establishing e-scooter recharge stations at convenience stores, large supermarkets and department stores, and cell exchange stations. Establishing stations will facilitate the development of the e-scooter industry, and automated recharge stations and RFID e-wallet payments demonstrate strong future potential. This research was limited by sampling retrieval limitations of the expert survey, and the probability and tendency of technology to evolve over time, which was excluded from the variants. The proposed models were generalized based on the professional consensus and did not include creative potential models of future commerce.

Future practical and academic studies could explore specifications and recharging times, the developmental model of cell exchange stations, moving lines, recharge station payment mechanisms, in-depth administration model cases, and optimal models.

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