Notes and Comments

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Using a TOWS Matrix in the Achievability-Effectiveness Analysis for Scooter Commuters Interchange to Public Transportation in Kaohsiung

The motor scooter (encompassing powered two-wheelers with cylinder volume up to 125 cc) is not a primary mode of transportation in most countries; however, its distinct characteristics appeal to a significant portion of the driver population in dense cities such as Kaohsiung (Taiwan). Kaohsiung is highly urbanized with mixed-use buildings for housing, retail, commercial/office, and amenities in urban areas—thus encouraging local employment and shortening travel distance. Local short trips, such as commuting, shopping, and daily errands like picking up or dropping off children at school, depend heavily on scooters and, to a lesser extent, on cars. According to data from the Transportation Satisfaction Survey (Beacon Marketing Research Company 2008 July), 68.5 percent of respondents commuted on scooters and 16.7 percent drove cars to work every day in 2008, compared with 63.8 percent and 24.2 percent respectively three years ago. And the average scooter commuting distance was 9.6 km for a single trip (Department of Statistics 2008).

However, this mode of private transportation has inevitably brought problems when put in massive use in urban areas. For example, massive scooter use in an environment with relaxed parking enforcement and lack of parking availability provokes commuters to park their scooters practically everywhere—on streets, shopping arcades, and public walkways. These scooters create obstructions that increase congestion and, consequently, pose a serious road safety problem. More importantly, the Kaohsiung government provides alternative options by introducing new metro transit services, reforming the city bus system, and encouraging cycling/walking activities. It also initiates several strategies in an attempt to increase demand for public transportation. These strategies have not generated substantial travel alternatives on weekdays. Massive scooter use therefore reduces the returns on public transportation infrastructure investments, both monetarily and socially.

To attempt to solve this problem, experts in relevant public and private sectors have held workshops and extensive discussions to identify issues to be addressed so as to divert scooter travel demand to public transportation for a sustainable transportation environment. Studies have suggested the important role of expert perceptions in addressing strategic issues. For example, Colombo et al. (2009) demonstrate that expert judgments can be taken as a proxy for citizen preferences for determining alternative investment strategies in Rights of Way Improvement Plans. Empirical studies, moreover, suggest that strategies for improving the use of public transportation alone have limited effects in attracting travel alternatives (Hine and Scott 2000; Kingham et al. 2001). They would need to be linked to policies to

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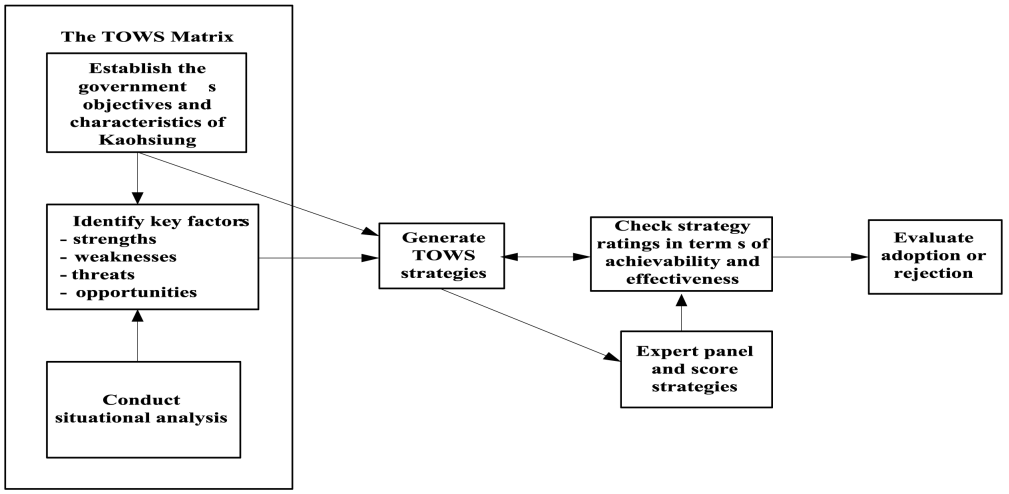
The authors would like to express their appreciation to Kaohsiung City Transportation Bureau for their support of this project. The views expressed are those of the authors and do not represent the official policy or positions of the Bureau.

Figure 1. The Strategy Generation Process



make vehicle use less attractive (Gärling and Schuitema 2007).

It is thus the aim of this article to explore collective local transportation strategies that can attract scooter commuters to interchange to public transportation based on expert perceptions. And, given limited funds, it is of strategic importance to evaluate strategies in terms of their relative achievability and effectiveness. Specifically, the article uses a combination of the TOWS (threats, opportunities, weaknesses, and strengths) matrix and the achievability-effectiveness analysis as an analytical framework to identify a feasible local transportation strategy mix. How the TOWS matrix works and its link to the achievability-effectiveness analysis can be used as a simple yet practical planning tool, and its benefits are described later in the article. We continue with illustrating how such an approach could lead to alternative solutions and conclude with some implications for planning.

Methodology

This article links the TOWS matrix to the achievability-effectiveness analysis in order to generate a range of feasible interchange strategies. The strategy generation process incorporating TOWS matrix and achievability-effectiveness analysis plus the enhancements from scoring strategies and checking adoption or rejection is shown in Figure 1. The TOWS matrix, a variation of SWOT (strengths, weaknesses, opportunities, and threats) analysis, was first applied to generate new strategies. Table 1 shows that the generation process began with a situational analysis to identify the strengths and weaknesses internal to the Kaohsiung government and the threats and opportunities presented by the external environment. These factors were then paired, e.g., an opportunity with a strength, to stimulate new strategies (Weihrich 1982).

A questionnaire was then developed to collect experts' opinions on the identified TOWS strategies. The experts were asked to answer two questions for each strategy in terms of relative achievability and effectiveness based upon their knowledge/experience for the subject and the perceived resources and constraints in the environment. An example is shown in Table 2. Additionally, the questionnaire grouped all of the achievability measures in one section and all of the effectiveness measures in a later section in order to minimize compounding and order effects. Pilot testing was performed on four faculty members of the Transportation and Communications Management Science Department at National Cheng Kung University to determine the acceptability and clarity of the questionnaire. A few minor changes were made before the questionnaire was mailed to thirty relevant transportation experts for final review and, later on, carried out at the expert panel meeting.

Table 1. The TOWS Matrix

	Internal Factors	
	Strengths	**Weaknesses**
	S1:	**W1:**
	S2:	**W2:**
External Factors	**. . . .**	**. . . .**
Opportunities	SO strategies: Maxi—Maxi	WO: Mini—Maxi
O1:	SO1:	WO1:
O2:	SO2:	WO2:
. . . .	. . . .	. . . .
Threats	ST: Maxi—Mini	WT: Mini—Mini
T1:	ST1:	WT1:
T2:	ST2:	WT2:
. . . .	. . . .	. . . .

Table 2. Examples of Achievability-Effectiveness Questions and Scoring Scheme for TOWS Strategies

Questions asked for each strategy, for example:

1. How achievable is the ''restrict scooter access'' (Strategy 1) compared to the other strategies?
2. How effective is the ''restrict scooter access'' (Strategy 1) compared to the other strategies?

And so on for other pairs

Scored on a continuous scale of 5 through 1 to 5 where, for example:	*Score*
Definitely achievable/extremely effective	5
Highly achievable/effective	4
Equally achievable/effective	3
Fairly achievable/effective	2
Not achievable/ineffective	1

Thirteen key transportation experts were invited to participate in a panel meeting to solicit input on the feasibility of implementing TOWS strategies. The first author of this article chaired the panel meeting. These experts included senior officers from local government (representing regulators), academic researchers (representing researchers), and practitioners from public transportation industries (representing operators). They had expertise and experience covering all aspects of urban transportation management in Kaohsiung. The questionnaire was distributed to and collected from these experts before the beginning of the meeting. The survey results were then reported for a discussion at the meeting.

Finally, survey results were incorporated into the achievability-effectiveness analysis, which was an easy-to-apply methodology in marketing studies (Martilla and James 1977). Martilla and James introduced this analytical tool by conducting a consumer survey on the relative importance and performance of identified attributes for an automobile marketing program. The survey results were graphically displayed on a two-dimensional grid to examine the degree of importance and performance of attributes. Presentation of the results on the grid facilitates management interpretation of the data and increases data usefulness in making marketing decisions. Accordingly, using the achievability-effectiveness analysis in the study helps regulators make strategic decisions. It also increases the precision of TOWS strategies by yielding key insights into which aspect of the strategy mix regulators should devote

more attention to as well as pinpoints areas that may be consuming too many resources.

TOWS Situational Analysis in Kaohsiung

Literature review, workshops, and extensive discussions with related personnel from government agencies and the public transportation industry were instrumental for a situational analysis in this study. The intention is to locate key factors affecting the Kaohsiung government's strategic position to convince commuters to forsake their scooters in favor of public transportation, using the broader categories of strengths, weaknesses, opportunities, and threats to organize key pieces of information.

Internal Strengths

The public transportation policy focuses on lowering the costs of various adaption alternatives and improving the quality of access/egress components of trips. Under the policy, the government introduced new metro services in April 2008. Currently, the metro system provides 128 one-way trips (every six minutes during peak hours and ten minutes for off-peak times [from 6 a.m. to 11:30 p.m.]) every day. The average daily ridership increased from 94,000 to 140,000 between April 2008 and January 2009. And the weekend average daily ridership was 140 percent higher than that of the weekday. This suggests a gradual increase in the frequency of metro use, particularly for trip-makers to get around in the city on weekends.

The government also allocated NT$120 million to acquire 320 new non-step median/low-floor buses in order to develop 24 new feeder routes and provide 59 one-way trips (every fifteen minutes during peak hours and twenty minutes for off-peak times) for each feeder route on weekdays. These new additions also enabled bus companies to offer comfort and safety for passengers by replacing old vehicles. Additionally, the government provided free feeder bus services to smartcard holders making interchanges within two hours. The ridership amounted to about 4.5 million from March 2008 to February 2009, of which 64 percent were free transfers and contributed to 10 percent of the total metro ridership. Finally, the weekday average daily ridership was 207 percent higher in comparison to weekends.

Besides developing feeder bus routes, the government is promoting cycling/walking activities. A 250-km cycling/walking network is scheduled to be completed in 2010, of which 20 km in length of commuting pathways were constructed in 2008. Cyclists are encouraged to park their bicycles at free parking facilities located at metro stations and on sidewalks. They can also rent a bicycle by participating in a citywide self-service rental program. These efforts have attracted trip-makers to ride bicycles, particularly for recreational purposes on weekends.

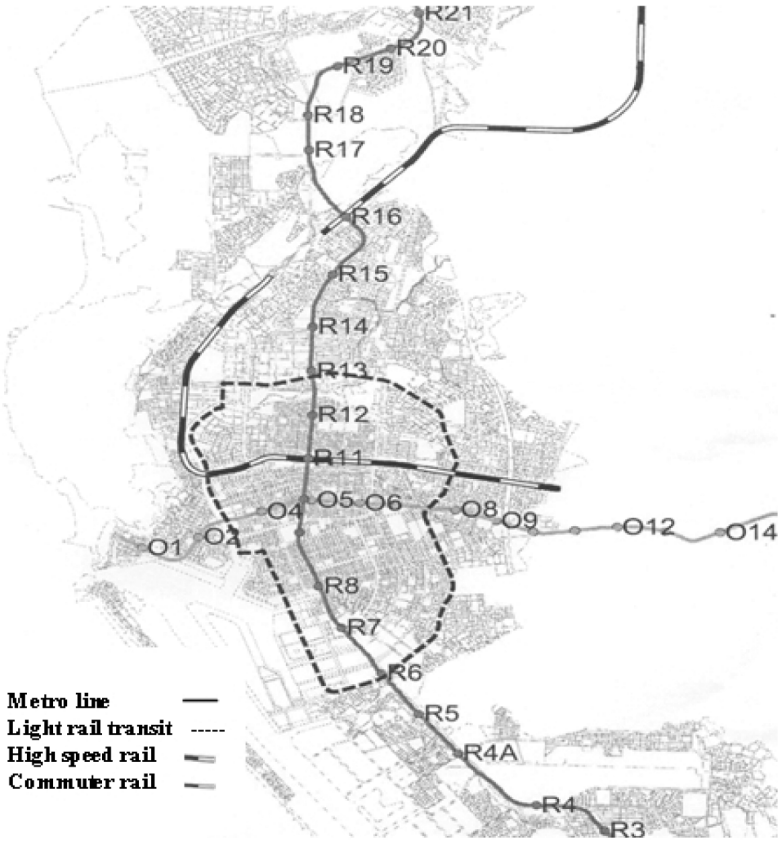
Internal Weaknesses

Under the public transportation policy, the government outlines an integrated network to include bus, metro, light rail, and intercity high-speed and commuter rails (see Figure 2). The metro system, which forms the backbone of the network, comprises south-north and east-west cross lines. Each line can transport 2,250 passengers in a single trip within 45 minutes. Both intercity high-speed and commuter rails link metro lines at R11 and R16 stations. The commuter rail has been reconstructed to provide an underground rapid service, but construction, which begins from R16 station (passes through R11 station) and ends parallel to O9 station, will not be completed until 2015. With trip frequency and price structure comparable to that of metro service, the commuter rail will expand metro transit accessibility. Besides buses, the light rail transit enhances the connectivity of the network by forming a circle line to link all rail and metro lines. However, it is under construction and scheduled to be completed in 2013.

Various comments from passengers referred to less reliable service and insufficient trip frequency as the two factors affecting bus service quality. The unsatisfactory bus service does not only lead to low ridership but impairs the government's ability to integrate bus and metro services and, consequentially, its efforts to promote the metro as an efficient and convenient commuting mode. This, in turn, boosts the government's financial burden to subsidize bus and metro operators for service rates and routes.

In order to facilitate interchanges between modes, the government has introduced a bus dynamic information system and completed a regional smartcard integration program. The

Figure 2. Public Transportation Network Outline



new bus dynamic information system provides real-time information through the Internet. However, the Annual Transportation Satisfaction Survey revealed that 11 percent of respondents did not have confidence in its accuracy (Beacon Marketing Research Company 2008 July). It also reported that access to information is not adequate.

Kaohsiung City has also cooperated with neighboring counties/cities by introducing two contactless fare collection systems—namely, TaiwanMoney Card and I Pass—to be used for buses, ferries, and parking lots. Recently, both smartcards have expanded their services to areas outside transportation, including a loyalty program in connection with retail applications. However, both intercity high-speed rail and commuter rail cannot yet accept either card due to the compatibility of their ticketing technologies, which results in inconveniences to intercity travelers.

External Opportunities

In 2008, there were roughly 14.3 million scooters registered nationwide and the average scooter ownership rate was 71 scooters per 100 people. Among the 23 cities and counties in Taiwan, Kaohsiung had the highest ownership rate. The huge scooter population brings concerns about ambient air pollution in urban areas since the scooter causes at least three times more pollution per kilometer than a passenger car in terms of hydrocarbon and carbon monoxide emissions (Chan et al. 1995; Vasic and Weilenmann 2006). It also brings concerns about driving safety and on-street parking management. A combination of these concerns, in turn, generates a negative effect on the nation's image and identity. Accordingly, the central government is subsidizing local authorities to tighten scooter restrictions and divert scooter travel demand to public transportation.

External Threats

The hot weather conditions in Kaohsiung facilitate year-round scooter use but impede cycling and walking activities for commuting purposes. The very friendly motorcycling environment enables scooters to achieve efficiency in driving and parking as well as faster access than cars in dense urban areas. These factors, together with very low running costs (a car's running costs are estimated to be around NT$5.2 per kilometer, while it is NT$1.84 for a scooter), short commuting distances, and unsatisfactory public transportation services, have generated an ingrained habit of riding scooters.

Commuters are very keen to ride scooters. Data from the Survey on the Impact of Fuel Prices on Mode Choice indicate that 27 percent of respondents switched modes for short trips due to fuel price surges, of which 14.68 percent are car drivers mainly switching to scooters or bicycles, while 12.32 percent are scooter riders switching to bicycles or walking (Department of Statistics 2008 July). Moreover, although it is NT$0.86 per kilometer cheaper to ride a bus than a scooter, a majority of commuters would still prefer scooters over buses because the cost difference is not sufficiently large and the feeder bus is perceived as a less reliable and inconvenient commuting mode.

TOWS Analysis Results

A summary of the above situational analysis generates twenty-one internal and external factors (see Table 3). If regulators are to deal with these threats and weaknesses, it will have to establish public transportation as a new commuting mode choice habit. The response to these factors requires a well-planned and strategic approach. Strategies are built on the strengths, eliminate the weaknesses, exploit the opportunities, or counter the threats. The resulting seventeen strategies are given in Table 3. The situational analysis suggests that the Kaohsiung government needs to improve feeder bus service quality; enhance public transportation accessibility; make the motorcycling environment less friendly; and internalize scooter running costs as all pairings pointed in that direction.

Achievability-Effectiveness Analysis Results

The identified seventeen TOWS strategies are further analyzed in terms of their relative effectiveness and achievability based on the data collected from an expert survey.[1] The thirty-four strategy ratings are then plotted as seventeen points on the achievability-effectiveness grid in Figure 3 in order to translate the results into action. The middle position constitutes the vertical and horizontal axes on the grid. The numbers refer to the strategies listed in Table 3. The labels of the quadrants A, B, C, and D refer to perceived feasibility. Interpretation of the grid is further discussed for each of the four quadrants.

''Possible Ineffective'' denotes an area (A) where the goals of strategies can be politically achieved but they might be ineffective. This does not necessarily mean that they are not worth doing, but they are not going to have much effect overall and probably should be implemented without using many resources. Strategies 4, 6, 12, 15, and 16 are classified in this area. Interestingly, to improve bus waiting areas and facilities (Strategy 15) receives a very low score in terms of effectiveness. Beirão and Sarsfield Cabral (2007) suggest that improving waiting areas is a good motivation to public transportation use based on commuter perspectives. However, without more reliable feeder bus services and higher trip frequencies, experts perceive that this strategy is more likely to reduce complaints from bus riders than to attract scooter commuters to interchange to public transportation. Therefore, Strategy 15 is easy to implement, but expensive improvements such as installing air conditioners are not necessary.

''High Priority'' denotes an area (B) where strategies are effective and also where the goals of strategies can be politically achieved. Concentrating on implementing strategies in this area would produce maximum results. Strategies 2, 7, 11, 14, and 17 are assigned in this area. Experts perceive that gradually restricting scooters from parking on shopping arcades and public walkways while simultaneously tightening parking controls in these areas (Strategy 11) will significantly increase the inconvenience of using scooters, making them less attractive. The strategy will also provide safe

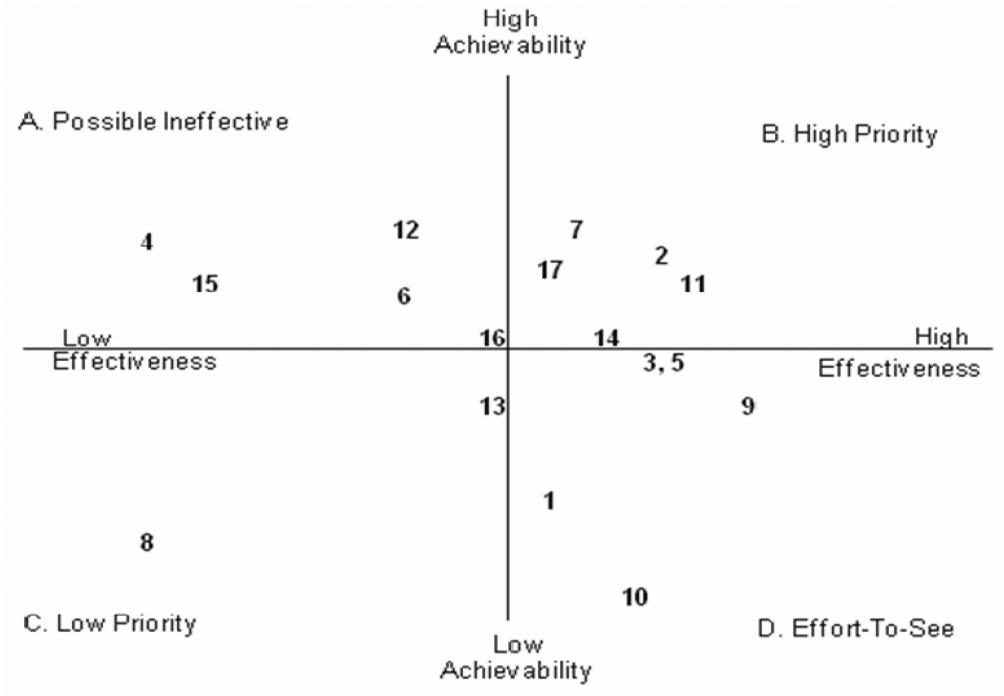
Table 3. The TOWS Matrix: Factors and Strategies

	Internal Factors	
	Strengths - public transportation policy - new bus acquisition - new metro service - free feeder buses - cycling/walking policy	**Weaknesses** - less reliable bus service - not enough bus frequency - incomplete public transportation network - poor public transportation links - unprofitable operations - regional smart card integration program - badly-maintained bus dynamic info system
External Factors		
Opportunities - increased environmental protection awareness - increased restriction on scooter use - a large number of riders as potential public transportation users	**SO Strategies** 1. restrict scooter access 2. introduce fare incentives 3. introduce a regional public transportation authority 4. enhance energy conservation program	**WO Strategies** 5. introduce bus priority lane and bus rapid transit system 6. improve feeder bus service monitoring mechanism 7. encourage government & non-profit organization staff to use public transportation services 8. promote car/taxi share as feedering modes
Threats - low motoring costs - increased fuel prices - hot weather condition - friendly motorcycling environment - an ingrained habit of riding scooters - a negative perception of public transportation services	**ST Strategies** 9. impose on-street parking fees 10. introduce congestion tax 11. ban scooters from parking on shopping arcades/public walkways and tighten parking controls 12. enhance public transportation promotion program 13. offer free park-and-ride lots nearby metro stations	**WT Strategies** 14. improve bus/bicycle and metro links 15. improve bus waiting areas and facilities 16. expand regional smart card integration program to nationwide 17. introduce an integrated well-maintained public transportation dynamic info system

and convenient access for other modes, such as cycling and walking.

Introducing fare incentives (Strategy 2) is perceived as both highly effective and easily achievable. The free feeder bus interchange program attracted 10 percent of commuters to switch to public transportation. It is therefore feasible for the government to offer a free or discounted feeder bus interchange service designed specifically for scooter commuters in order to increase the share of combined modes from this group. Experts also perceive that improving cycling/walking and bus links to metro services (Strategy 14) should enhance public

Figure 3. Achievability-Effectiveness Grid with Strategy Ratings



transit accessibility and improve the perceived inconvenience of using combined modes in one trip.

''Low Priority'' denotes an area (C) where strategies are not perceived to be feasible by experts. Strategies in this area should be given a low priority. Strategies 8 and 13 are found in this area. The car/taxi sharing program (Strategy 8) implemented either by car/taxi pooling with a relatively larger group of members or by neighborhood-based short-term car/taxi rental may be a viable alternative to reducing car trips (Fellows and Pitfield 2000; Roberts 2001) but not to scooter trips. The sharing program attracts long-distance trip-makers, but scooter trips tend to be short.

''Effort-To-See'' denotes an area (D) where regulators would need to devote more efforts and resources to make strategies work. Strategies in this area should still be considered even though they might consume more resources. Strategies 1, 3, 5, 9, and 10 are grouped in this area. Experts perceive that introducing bus priority lanes (Strategy 5) will significantly improve trip frequency and reliability. Introducing on-street parking fees (Strategy 9) is viewed as a highly effective way to internalize scooter running costs. According to Hsu and Lin (2005), the parking pricing scheme combined with an efficient public transportation system has successfully encouraged many scooter commuters to interchange to public transportation in Taipei City (Taiwan).

Strategic Development in Kaohsiung, 2009

The achievability-effectiveness analysis in the previous section provides planners with a useful focus for developing strategies to encourage commuters to forsake scooters in favor of public transportation. Based on the perceived feasibility by experts, all strategies in the area (B) and the three relatively highly effective strategies in the area (D) are proposed to the Kaohsiung government. The resultant collective strategies are listed in Table 4.

Conclusions

This article provides a real application of an analytical framework to transportation policy making in a city with extensive scooter use. The article has two key objectives. First, it

Table 4. Proposed TOWS Strategies

- Introduce fare incentives	- Introduce on-street scooter parking fees
- Encourage government & non-profit organization staff to use public transportation	- Ban scooters from shopping arcades/public walkways and tighten parking controls
- Improve bus/bicycle and metro links	- Introduce bus priority lane and bus rapid transit system
- Introduce a regional public transportation authority	- Introduce an integrated public transportation dynamic info system

demonstrates that a combination of a TOWS matrix and achievability-effectiveness analysis pinpoints strategies that are feasible to implement. Second, it highlights the critical importance of expert perceptions in addressing strategic issues as well as highlighting more immediate concerns. Using Kaohsiung (Taiwan) as an example, the findings suggest the following feasible collective local transportation strategies: provide fare incentives, improve mode links, broaden information access, internalize scooter running costs, and make motorcycling environment less friendly. These strategies are aimed at encouraging commuters to forsake their scooters in favor of public transportation.

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Endnote

[1]Before starting the analysis, it is important to check data for possible outliers because outliers would strongly affect the mean and standard deviation of variables. The Chauvenet's criterion was applied to remove outliers. It was confirmed that virtually identical results would have been obtained using median rather than mean values; accordingly, mean values were used here to represent a measure of central tendency and to avoid discarding the additional information they contain.