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Sustainable Environmental Management Through a Municipal Solid Waste Charging Scheme: A Hong Kong Perspective

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Municipal solid waste (MSW) charging is a method of waste management that involves charging residents for garbage disposal. Due to the increasing levels of MSW, Hong Kong has planned to implement an MSW charging scheme in 2023. This article evaluates the potential efficacy and challenges of an MSW charging scheme in Hong Kong. We first summarize the experiences from Taipei and Seoul, which are two typical cities that have successfully implemented the charging scheme to handle MSW. Strong enforcement and good supportive resources in the two cities have resulted in highly effective MSW management. We then provide an IPAT analysis of the urgency of Hong Kong's MSW concerns and a PEST analysis of the readiness of Hong Kong to implement MSW charging. We highlight the challenges with actionable suggestions for sustainable environmental management.

Keywords: municipal solid waste, waste charging scheme, sustainable development, waste management, environmental sustainability

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INTRODUCTION

Municipal solid waste (MSW) is total waste, which includes domestic solid waste from households and public areas and commercial and industrial solid waste. The statistics for Hong Kong indicate that the disposal rate of MSW was 11,057 kg/day in 2019, which accounted for 71% (4.04 million tons) of total waste generation (5.67 million tons), with only 29% of recovered waste (1.64 million tons). Given the significant volume of waste being generated and little reduction from the source, landfills will soon overflow, and the daily operation of Hong Kong city will be drastically affected. Thus, the increasing levels of MSW have become a challenge for the sustainable development of the city (Zhou and Zhang, 2022). Although many studies have discussed the potential of MSW for generating energy such as biogas, hydrogen, and methane (Yeshanew et al., 2018; Yaman, 2020; Atchike et al., 2022), reducing waste from the source is a priority in the waste hierarchy principle (Zhou and Zhang, 2022). As shown in **Figure 1**, preventing and reducing waste are the favored options for sustainable waste management. The economic intuition of waste charging is straightforward: imposing a disposal fee moves the waste disposal curve upward as the cost for disposal increases from P1 to P*, which induces a reduction in waste disposal from the level of Q1 to Q*. In view of the success of implementing the MSW charging scheme in other regions, Hong Kong passed the MSW charging scheme in August 2021, and it will take effect in 2023.

MSW charging methods can be classified into four major approaches: a quantity-based system, a proxy system, a fixed charge system, and a partial charging system (Alzamora and Barros, 2020).

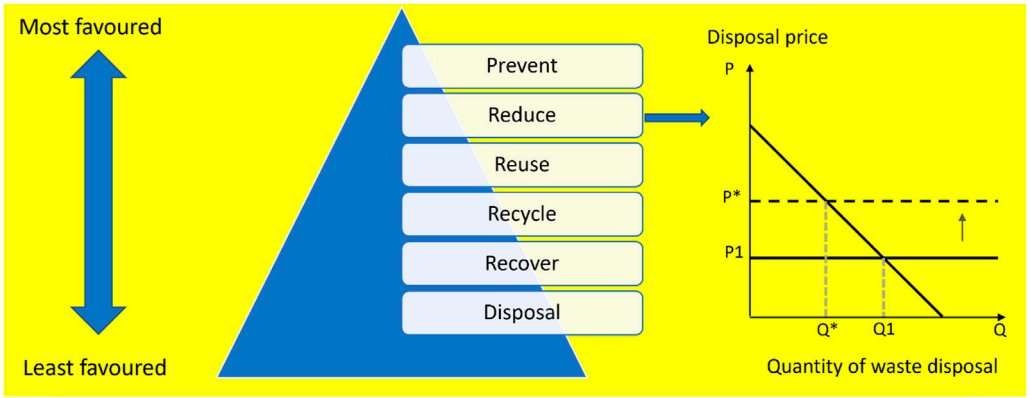

FIGURE 1 | Waste hierarchy and the economic foundation of the waste charging scheme.

Hong Kong has opted for the quantity-based system. A quantity-based charging system establishes a direct relation between the quantity of waste dumped and the amount charged for waste disposal. It can be implemented by charging citizens either per specified volume of waste, per weight of waste, per bag of waste, or according to waste collection frequencies, depending on the source of waste. The larger the amount of solid waste disposed of, the higher the external cost that one will have to pay. The purpose of the scheme is to make people more aware of waste disposal and to try to reduce waste through reusing, reducing, and recycling. As the government has laid out in the "Hong Kong Blueprint for Sustainable Use of Resources," waste reduction is one of the targets for achieving sustainable development goals of the city. Therefore, the successful implementation of the MSW charging scheme is of importance for Hong Kong's environmental sustainability.

In Hong Kong, the charging scheme is proposed to be implemented through two modes: the designated garbage bag and the weight-based "gate-fee." In the designated garbage bag mode, citizens will be required to use pre-paid designated garbage bags for small-sized solid waste and designated labels for larger waste. After the official launch of the charging scheme, these prepaid bags and labels will be sold at approximately 400 selling points, including supermarkets, convenience stores, post offices, and automatic vending machines in the streets. Citizens living in residential buildings and village houses and those who are engaging in economic activities in commercial and industrial buildings and street-level shops will be required to purchase these designated garbage bags and labels. Most household wastes will be charged using this method. The pre-paid garbage bags have nine different sizes, ranging from 3 to 100 L. The prices of the designated bags range from HK$0.3 to HK$11, with a rate of $0.11 per liter.

In the weight-based "gate-fee" mode, industrial or commercial premises that usually produce large amounts of solid waste every day will have to pay a fee that is based on the weight of the waste. This type of waste is usually irregular in size and shape and occupies a considerable amount of space in garbage collection vehicles. It is collected and disposed of by collection vehicles that have pneumatic waste collection systems rather than compactors. A "gate-fee" ranging from $365 to $395 per ton will be charged, and no garbage bag or label will be required.

The advantage of the scheme is that it can incentivize the public to reduce waste by increasing the costs of waste disposal (see **Figure 1**). Additionally, the scheme adds the costs of the environmental impact into waste disposal behavior, which provides an incentive for the public to reduce waste. However, strict enforcement and a sound recycling scheme are essential if the scheme is to be successful. The government must also put an end to illegal disposal of waste. Common measures to prevent illegal disposal are strengthening the penalty for illegal disposal through legislation and increasing the number of enforcement staff. For the recycling scheme, the government should provide clear instructions and convenient collection points for the public so that people have easy access to recycling facilities after they separate the recyclable material.

EXPERIENCES IN OTHER REGIONS

Many regions and cities have successfully implemented the MSW charging scheme, for instance, Japan (Sakai et al., 2008), Spain (Puig-Ventosa, 2008), and Portugal (Ferreira and Marques, 2015). **Table 1** provides information on waste charging schemes across countries. It shows that economic tools such as a disposal fee or tax have been widely used to incentivize reduction of municipal solid waste. In this section, we discuss Taipei and Seoul, which share certain economic and social similarities with Hong Kong and have utilized the MSW charging scheme to manage waste in the city. The results from these cities can also provide an outlook for the effectiveness of the MSW charging scheme in Hong Kong.

Taipei

As explained by Lu et al. (2006), Taipei's MSW management can be divided into four stages with various management tools carried out simultaneously. Prior to any government intervention, the rapid economic development that occurred in the 1980s was accompanied by an equally rapid increase in MSW. In 1990,

TABLE 1 | Waste charging methods by countries.

Country	Charging methods for MSW
Australia	Waste levies are imposed in many regions such as New South Wales and Victoria. Levies vary between states
Canada	A rate-based program where residents pay fees for the services they receive. Households are encouraged to divert garbage from landfills
Denmark	A fixed rate that varies depending on the method of collection
Finland	Deposit–refund systems for beverage packaging
France	Municipal waste tax (*taxe d'enlévement des ordures ménagères* - TEOM)
Greece	Solid waste charging based on the household area, and different households and businesses are charged differently
Germany	Basic fee, bin fee for residual waste and bio-waste, and transportation fee
Iceland	Recycling fee instead of landfill and incineration taxes; deposit system on beverages and end-of-life vehicles
Italy	Italian waste tax (*tassa sui rifiuti* or TARI), including a fixed part and variable part
Japan	Over half of Japanese municipalities charge for MSW services
Netherlands	Almost all municipalities impose a MSW fee, which may be a fixed amount, set according to the size of the household, or based on the volume of waste
Norway	Fees vary according to the costs of service delivery in a community, with only limited progress in differentiating fees according to the amount of waste generated
Poland	Municipalities can choose between three nationally determined approaches—fees can be set per head, by area of home, or on the basis of water consumption. Fees are lower for households that separate waste
South Korea	A volume-based waste fee system applies to the collection of mixed household waste and food waste. Separate collection of recyclable waste is free
Singapore	Refuse collection fees for households to $9.63 per month (incl. GST) for HDB/private apartments and $32.07 per month (incl. GST) for landed homes
Spain	A fixed flat annual fee is set for households, and there is a variable fee depending on the consumption of standardized bags for refuse and packaging
Sweden	A waste collection charge is set by the municipal council. To achieve a higher recycling rate for waste, several municipalities have introduced a weight-based charge, where households pay an additional rate per kilo of waste collected on top of the basic charge
Switzerland	Household refuse is only to be collected if it is in bags that either have a payment sticker attached, are official bags with the surcharge paid when the bags are purchased, or are weighed at central collection bins. The disposal of recyclable waste is mostly free of charge
United Kingdom	Landfill tax. Wastes suitable for recycling are exempted from the landfill tax but are subjected to a process charge
United States	A wide variety of policy tools that vary across states, such as pay-as-you-throw administered at the municipal level and the deposit–refund systems or container deposit legislation, also known as "bottle bills"

TABLE 2 | IPAT analysis.

Scenario		Population (*P*) in million persons	Affluence (*A*) per capita income measured in 1,000 USD	Technology (*T*) measured in tons/million USD	Impact (*I*) in million tons of waste
In 2019	Baseline	7.52	48.35	11.11	4.04
In 2050	BAU	8.05	48.35	11.11	4.32
	Growth	8.05	65.82	11.11	5.89
	Green	8.05	65.82	5.56	2.95

Taipei realized the importance of waste avoidance and reduction and rolled out four stages of waste management. Before implementation of any measures that targeted ordinary residents, the extended producer responsibility (EPR) program and recycling programs were introduced. These programs required manufacturers and retailers to set up recycling organizations that specialized in waste recycling and classification. Meanwhile, a series of measures were enacted that included fostering public education on recycling, setting up multiple recycling sites, and arranging garbage collection trucks at designated spots, all of which enabled residents to classify and dispose of waste under the guidance of specialized personnel. These measures resulted in a reduction in the level of MSW prior to the mandatory scheme being introduced.

The Taipei government proposed the MSW scheme in 2000. The waste collection fee is based on the "pay-as-you-throw" (PAYT) system, which is assessed by the volume of waste generation. Under the scheme, residents who need to dispose of waste are required to purchase an Environmental Protection Bureau-authorized designated garbage bag with a volume of 1 kg at a cost of NT$0.45 (equivalent to HK$0.13). Immediately after the establishment of the PAYT system in Taipei City, the city government started a recycling program to collect and recycle all household kitchen waste separately. Since 2003, household

kitchen waste has been recycled for animal feeding (pig-feed waste) and agricultural use (compostable kitchen waste).

Taipei has now run the 4-in-1 Recycling Program for over 20 years. The EPR scheme collects recycling, clearance, and disposal fees from manufacturers and importers to create a recycling fund. The fund then subsidizes the recycling disposal system and extends the responsibility of these businesses (Fan et al., 2005). This approach provides sufficient economic incentives to promote the growth of recycling and reuse enterprises and generate output value and job opportunities. This designed feedback mechanism encourages local cleaning crews and the general public to recycle even more, thus forming a "cycle." This scheme is significant, with more than 1,600 recycling companies operating in 2015 that resulted in US$2 billion earnings in that year. According to Taiwan's Environmental Protection Administration, approximately 180,000 tons of waste plastic were collected and converted into $140 million in raw materials in 2014 alone.

Thus, recycling has played a pivotal role in Taipei's success with waste reduction. To improve recycling, the government implemented a set of strategies to raise societal acceptance and public participation (Su et al., 2007). Before implementing the charging scheme for waste management, the Taipei City government adopted soft strategies to promote recycling, thereby paving the way for an easier implementation of a full mandatory charging scheme, which received little opposition from citizens. These strategies included the development of people's habit of recycling and the government's active participation in promoting recycling and providing recycling facilities.

Seoul

In Seoul in South Korea, during the 1990s, the government observed that the increasing levels of MSW had become a problem, and in 1995, the MSW charging scheme was implemented. Before the implementation, only fixed charges and property taxes were paid by its citizens, and these were independent of how much waste the citizens disposed of. Similar to the MSW charging scheme proposed for Hong Kong, the MSW scheme in Seoul is a quantity-based MSW charging system that charges by the volume of garbage bags (Hong, 1999). Since the MSW charging scheme was implemented, a significant decrease in waste disposal of 40% has been evident over the past few years. One reason for this reduction is that a portion of the waste was recycled, as there is no charge for disposing of recyclable objects in designated recycling areas. Apart from recycling, the Seoul government designed another policy to incentivize the public to follow the rules, as many citizens tried to dispose of their waste without paying the required charges. The government provided sponsorship to encourage the public to take part in the monitoring of "fly-tipping." Anyone who reports fly-tipping is rewarded with a maximum of 80% of the offender's penalty.

According to statistics from the Korea Institute of Industrial Relations and Korean Environment Corporation (2013), in the first 10 years of implementation (1995–2005), the quantity of waste disposed reduced by 624,880 tons per year while the quantity of recycled waste increased by 321,565 tons per year. By 2019, the average daily volume of waste recycled increased to 403,350 tons in South Korea. One ton of waste reduction generates a net benefit of HK$955.5, and one ton of waste recycling is associated with an earning of HK$125.6. In total, it is estimated that the net benefit of MSW charging is HK$637.3 million per year. In addition, the environmental benefits from the MSW treatment can bring further economic revenue as the society becomes more sustainable and environmentally friendly. Therefore, it is apparent that the design of Seoul's MSW charging is beneficial, and it could be expected that the Hong Kong's charging scheme would generate revenue for the city.

What Can We Learn From the Two City Cases?

Although the two cities implemented the waste charging scheme in different years using various methods, both share successful experiences from which to learn. First, as documented clearly, the waste charging scheme was introduced in both cities using a phase-wise implementation plan that moved from public debate, to legislation, to formal introduction, and to full adoption. This phase-based approach allowed local government to collect sufficient information and to revise and update the policy as required.

Second, both cities sought sufficient public support, which involved a sufficiently long preparation stage in both cities. Taipei introduced the ESR program and recycling programs to encourage industrial waste management while also carrying out public education to increase residents' awareness of recycling. In Seoul, early adoption of effective separation of recyclables reduced the demand for waste treatment facilities and increased public support for sustainable waste management. Moreover, Seoul continued its cooperation with the public by encouraging residents' participation in the evaluation of the scheme. The positive evaluations from the members of the society have contributed significantly to the change in attitude seen in the mass media and the national consciousness.

Third, in addition to the waste charging scheme, a number of complementary policies were utilized to improve the rate of compliance with waste charging. Illegal dumping is one of the central issues to be resolved. To prevent this, Seoul uses reflectors to monitor illegal dumping, imposes penalties for illegal disposal, and provides free waste bags for low-income households. In Taipei, tariffs have been imposed for disposal at landfills, and penalties are applied to the illegal receiving of regulated waste.

HONG KONG PERSPECTIVE

Importance of Implementation of MSW Charging

Hong Kong is facing serious waste problems, resulting in grave concerns for environmental protection. While Hong Kong's population grew by 32% in the past 30 years, waste disposal increased by 68%. Therefore, solid waste management is an urgent matter that needs to be resolved as soon as possible.

Waste disposal in Hong Kong relies mainly on landfilling, and due to the cost of the land available, there is a limited capacity to expand the landfill sites. Thus, a more sustainable method is required to handle solid waste.

We first employ the model of IPAT identity (York et al., 2003) to illustrate the urgency of the waste problem in Hong Kong. The IPAT identity decomposes total environmental impact (I) into three multiplicative components, population (P), affluence (A), and technology (T), as follows:

$$I = P \times A \times T.$$

In 2019, the Census and Statistics Department of Hong Kong reported that the per capita income was about US$48,350, and the population at the end of 2019 was 7,520,800. A total of 4.04 million tons of MSW ended up in landfills that year. Therefore, the technology level can be computed as 11.11 tons of MSW created for one million US dollars of expenditure on average. In a business as usual (BAU) scenario, holding others constant, a 7% increase in population by 2050 (United Nations, 2019) would mean an annual waste disposal of 4.32 million tons in 2050. When the economy of Hong Kong grows at 1% (growth scenario), the per capita income (A) will be approximately US$65,820. Therefore, the total MSW will be 5.89 million tons, which is an increase of over 45% from the 2019 level. Finally, if we calculate a green scenario that assumes there is a technology or policy that could lower waste generation by 50%, total waste can be reduced to 2.95 million tons, that is, total MSW could be reduced by 30% in spite of a continuous increase in population and wealth. Please see **Table 2** for details.

This scenario-based projection illustrates the urgency of the Hong Kong's MSW problem and the significant potential for reducing MSW through technology or policy intervention. Thus, the MSW charging scheme can play a significant role in resolving the problem.

Is Hong Kong Ready for MSW Charging?

To answer the question of whether Hong Kong is ready for MSW charging, we borrow the PEST analysis. PEST stands for political, economic, social, and technological, which is a standard management tool that is used to assess major external factors that influence an operation.

Hong Kong is ready for implementing MSW charging from a political perspective. Extended producer responsibility has been widely used in many countries as an integral component in sustainable waste management (Hanisch, 2000; Forslind, 2005; McKerlie et al., 2006; Gupt and Sahay, 2015). In Hong Kong, the producer responsibility scheme (PRS) is the key policy tool for managing waste. It requires the relevant stakeholders to share responsibility for avoiding and reducing the environmental impact at the post-consumer stage. The Product Eco-responsibility Ordinance was enacted in 2008 with broad public support, and in order to achieve its ambitious target of carbon neutrality by 2050, the Hong Kong government has also drafted a waste blueprint for achieving satisfactory waste management by 2035 that includes waste reduction, zero landfills, and resource circulation. MSW charging is one of its policy tools for addressing the waste management of the city.

The MSW charging scheme is economically viable, as has been proven in the cases of Taipei and Seoul. In addition to the environmental benefits arising from reduced waste, the revenue generated from waste disposal fees could be used to develop the recycling industry and invest in waste-to-energy or green technologies which further increases the benefits of the waste charging scheme from a societal perspective.

We now turn to the social perspective. Public support is an important factor in the smooth implementation of the policy. In fact, residents in Hong Kong have shown a positive attitude toward the scheme. According to the results of a survey conducted by the Hong Kong Institute of Asia-Pacific Studies (2012), about 60% of the interviewees agree or totally agree in principle to introducing a garbage levy to reduce solid waste. After further analyzing the socio-economic background of the interviewees, the results showed that more interviewees with a monthly income of less than 10,000 and who think they are in the lower or lower-middle class disagree or totally disagree with introducing waste charging than those in other groups such as the middle class or upper class. It is possible that people with lower incomes may not be able to afford the MSW charges, which results in them disagreeing with the waste charging scheme.

Yeung and Chung, (2018) also surveyed the attitude of Hong Kong residents to the waste charging scheme. Of the 753 respondents, more than 60% indicated that they were willing to pay at least HK$30 each month for waste disposal. Their attitudes toward the MSW scheme were positive because they felt responsible for protecting the environment and believed that the scheme was effective in reducing waste. Chung and Yeung, (2019) further found that the average willingness-to-pay for waste disposal is HK$38.4 per month. Overall, a majority of the citizens in Hong Kong has shown support for MSW charging. The government, however, needs to consider a complementary policy that could incentivize the low-income group to support the MSW charging scheme.

In general, the purpose for implementing MSW charging is to promote the reduction of solid waste and to achieve environmental sustainability. The key to the successful implementation is the recycling rate of the society. Another important strategy is cracking down on illegal disposal, which requires strong enforcement from the Hong Kong government. However, it is difficult for Hong Kong to follow Taipei's monitoring system, due to its high-density residential areas. In Hong Kong, most of the residential buildings are multi-family dwellings where residents have to go to the shared refuse room to discard the waste (Ng, 2019). Therefore, it is difficult to track which flat the waste came from. Also, hiring additional manpower to carry out spot checks is not efficient, as the probability of the watchman having a spot check while the residents are throwing out rubbish is relatively small. Installing CCTVs in every refuse room is a possible strategy; however, the cost of installation and maintenance and the residents' lack of willingness to pay this fee to observe their activities are not a practical strategy.

Technologically, it is necessary to determine the readiness of the waste-recycling industry. Although Hong Kong has made significant investment in waste-to-energy facilities in recent years,

the recycling industry in Hong Kong is still not well prepared. The purpose behind the MSW charging is to reduce the amount of garbage at the source and then recycle as much waste as possible; however, as the current recycling facilities in Hong Kong are inadequate, there is no place to recycle and reduce the waste deposited in landfills. To understand how to resolve this issue, the Hong Kong government can look to the experiences in Taipei and Seoul. In Taipei City, waste collection fees began in 2000, and waste sorting and recycling were compulsory by 2005. According to the Department of Environmental Protection of the Taipei City government, the rate of a proper garbage disposal has reached 100%, and the waste incineration rate has reached 99.23%. In Seoul, the recycling industry developed more vigorously after the implementation of the garbage levy, driving the size of the industry from HK$1.7 billion in 2001 to HK$7 billion in 2009 (Cho and Kang, 2017).

It would therefore appear that waste charges offer an opportunity to improve local recycling facilities and promote the recycling industry, as people will look for recycling outlets for their recyclable waste. Also, anaerobic digestion technology can be used to decompose food waste into biogases such as methane and carbon dioxide, which can be converted into heat and electricity for plant use. Therefore, the government should strategically support the recycling industry in line with waste composition and the recycling technologies available in Hong Kong.

Actionable Recommendations for Successful Implementation

In view of the Hong Kong situation, we discuss the actionable recommendations for successful implementation of the MSW charging scheme.

Resource support: The government can provide a range of resource support. First, it can provide general support to ordinary residents. Currently, the government provides a recycling hotline for the public to organize for free collection of their recyclables.

Second, it can provide special support to low-income residents. Chung and Yeung, (2019) highlighted that the low-income household group does not support the MSW charging scheme as it increases the financial burden on the household. It is thus necessary to provide resources to those in the low-income group to mitigate their concerns. One approach we can borrow from the Seoul case is to provide the standard rubbish bag free of charge to this group. Lo and Liu, (2018) also identified the income effects on waste recycling and suggested that the government should distribute more site-specific recycling bins in economically disadvantaged residential communities.

Third, it can provide funding support for the recycling industry. The local recycling industry plays an important role in managing waste in Hong Kong. The recycling fund is one of the supporting strategies that the government utilized to promote the development of the recycling industry. One of the major profit sources for the local recycling industry is to sell the waste to mainland China. However, with the mainland ban of importing waste, many firms in the industry are hard to survive. Therefore, government funding for the recycling company is indispensable, otherwise there will not be enough recycling companies to deal with the recycled waste. It is known that the Environmental Protection Department launched the Environment and Conservation Fund (ECF) to support both research on the recycling technologies and practical programs for resident's organizations and property management companies. It is therefore advised that the government should not only extend funding support to expand the recycling industry but also subsidize research projects on lowering recycling costs.

Institutional preparation: As a complement to the waste charging scheme, the government can introduce a reward system for the society. People can collect points to obtain materials or services as a reward for producing less waste. Although the cost of producing waste is the same, as people throw away more waste, they will lose the opportunity to obtain free materials or services. Therefore, introducing the reward system induces citizens to consider the opportunity costs of each alternative action when making any decision. In other words, their opportunity cost of producing waste increases. It provides the incentive to decrease the amount of waste. This is in line with the suggestions made by Mak et al. (2019), who highlighted the role of regulatory compliance and economic incentives in determining recycling intention.

As there are difficulties with monitoring and enforcing the polluter's behavior, a reporting system similar to that of Seoul would be helpful. Citizens can report polluters who are violating the scheme, such as not using designated garbage bags and designated labels. When they have reported the violator, they can gain rewards, which could increase their incentive to report more people and obey the policy, and the effectiveness of monitoring the polluters could also increase.

Environmental education: Studies in the literature have shown that environmental knowledge changes public environmental attitudes and improves public support for environment-related activities (Heimlich and Ardoin, 2008; Wiek et al., 2011; Schultz, 2013). The cases of Taipei and Seoul have also shown the importance of environmental education in increasing the citizens' recycling rate. The recycling rate in Hong Kong is about 30% (Lee, 2020). Increasing the recycling rate through environmental education is one way to deal with the overwhelming solid waste and the landfill problem in Hong Kong. Jin and Li, (2020) found that increasing environmental awareness through education can increase citizens' willingness-to-pay for environmental protection. Therefore, with better environmental education, citizens can pay more for protecting the environment. It takes a long time to build public awareness about recycling. Taipei has been teaching waste management and recycling in schools since the 1980s, which was long before it implemented MSW charging in the 2000s.

In fact, Hong Kong has been educating guidelines on environmental education in schools since 1992 (Lee, 1997). With increasing concerns about environmental sustainability, Hong Kong is adopting an integrated approach to promoting sustainable economic development that comprises green finance, green government, and green education. To educate the next generations, Ardoin and Bowers, (2020) concluded that nature-rich environmental education can nurture the development of appropriate pro-environmental behaviors in children. However, environmental education shall also be given to groups who have indicated low support for the waste charging scheme. This

education will help them understand the necessity and the potential benefits of sustainable waste management. Overall, Hong Kong should improve its environmental education by identifying target groups and providing more tailored environmental information.

Levy price: The charging scheme relies on the price mechanism it sets. Therefore, the level of the garbage bag levy is critical and requires regular review. Hong Kong implemented the Plastic Shopping Bag Charging Scheme in 2009; however, the levy price of HK$0.5 was too low to encourage people to reduce their use of plastic shopping bags. The MSW charging rate will be HK$0.11 per liter on average, similar to Taipei's ongoing PAYT system of around HK$0.1 per liter. However, as the average monthly income in Hong Kong is 1.78 times higher than that of Taipei, when Hong Kong operates the MSW charging scheme, the price incentive for residents in Hong Kong to reduce waste is lower than that of Taipei. In order for Hong Kong to be successful in MSW management, the price should induce more pro-recycling behavior change.

Therefore, it is necessary to carry out assessments of the economic aspects of MSW management. The cost of waste management processes should be estimated based on various factors (Martinez-Sanchez et al., 2017). Follow-up research could be undertaken using this table to review the cost and benefits of the MSW charging scheme and revise the levy price regularly to maintain its incentive.

To sum up, for MSW mitigation, it is crucial to develop a holistic approach with an effective policy mix. Dhanshyam and Srivastava, (2021) illustrated how policy interdependencies affect plastic waste mitigation in India. Given the long-term nature of sustainable waste management, we argue that Hong Kong should consider a phase-wise implementation with policy mix for implementing the waste charging scheme. In the preparation phase, an educational campaign should be launched to further disseminate information on the environmental and economic benefits of waste recycling. Also, a credit and penalty system should be introduced to the public as early as possible. In the implementation phase, the levy price should be regularly reviewed and revised to ensure that it is high enough to encourage waste recycling. Meanwhile, the government should provide support to both the recycling industry and the low-income group. Similar to the Taipei experience, Hong Kong can form its own X-in-1 recycling program that includes the waste charging scheme, PRS, and other related policies and initiatives. In the post-implementation phase, it is also useful to conduct systematic surveys to evaluate the effectiveness of the policy.

CONCLUSION

This article provided a perspective analysis on the MSW charging scheme that will be implemented in Hong Kong in the coming year. We first summarized the experiences of Taipei and Seoul, which are cities that have similar economic and demographic characteristics to Hong Kong. The experiences from the two cities show that strong enforcement and good supportive resources have resulted in highly effective MSW management. However, whether a policy can operate effectively or not would depend on the implementation strategies that are cognizant of the socio-economic and demographic characteristics of the varied segments of the population.

We then provided a scenario-based IPAT analysis of the urgency of the Hong Kong MSW concerns and public attitudes toward waste management. As discussed in this article, MSW management has become an emerging environmental concern in the city, which means that the MSW charging scheme in Hong Kong has had wide public support. However, there have been challenges and difficulties. The initial level of the levy price depends on the level of public acceptance and willingness-to-pay, and adjustments can be made after residents and other stakeholders become accustomed to the system. Also, the recycling rate will be the key for analyzing how effective is the MSW charging policy in solving waste issues in Hong Kong. This recycling rate requires a high level of resources and institutional support from the government and an intensive environmental education program. To solve Hong Kong's MSW issue, we suggest a phase-wise implementation plan with policy mix for a successful implementation of the waste charging scheme in a city with a high population density.

Overall, this article contributes to the sustainable environmental management literature by discussing the critical issues related to the implementation of the MSW charging scheme in Hong Kong. It shows the significant potential of the MSW charging scheme for solving Hong Kong's waste problem. This is the first but important step in Hong Kong moving toward environmental sustainability. However, gaps remain between the strategy plan and the formal implementation. Future studies that use rigorous data analyses are needed to evaluate the effectiveness of the scheme after it has been implemented.

AUTHOR CONTRIBUTIONS

CC and YZ conceived the idea and outlined the brief. LZ wrote the first draft of the manuscript. All authors contributed to manuscript revision and have both read and approved the submitted version.

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