

# Community Based Waste-to-Market Model for Sustainable Municipal Solid Waste Management: Closing the Ecological Loop

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## Abstract

Urban community was the key sector of municipal solid waste (MSW) management, and a sound community-based waste management could promote waste reduction, materials separation and resource recycling. To increase the efficiency of source separating and recycling, a community based waste-to-market (WtM) model was designed, which integrated the concepts of extra bonus for separating organic wastes, government funds for waste reduction, introducing small recycling enterprise for promoting source separation, etc., and a demonstrating project of WtM model was completed in a community with 76 households in Guiyang City, Southwest China. The WtM model could close the ecological loop of urban ecosystems, and it had great potential for the sustainable municipal solid waste management. After operating the project for one year, the waste reduction rate was 87.31%, and the comprehensive net benefit under WtM model increased 18.3 RMB.ton<sup>-1</sup>, compared to which under the normal model. The stakeholder analysis showed that the centralized MSW disposal enterprises had minimum interest and may oppose the new recycling system; while the small recycling enterprise had the primary interest in promoting WtM model, but they had the lowest power to make any change of current recycling system. The strategies for promoting WtM model were also discussed in this paper.

**Keywords:** waste-to-market model; community; municipal solid waste; source separation; recycling; Guiyang

## 1. Introduction

Municipal solid waste (MSW) management had become an important issue in urban sustainable development in China, due to the rapid increasing of waste quantity and the growing pressure of its environmental pollutions. The municipal solid waste generation increased 5% each year in recent ten years in China, and the annual waste generation had reached to 160 million ton in 2012 (MOHURD, 2012), and the World Bank estimated that the total waste generation of China will reach 480 million ton in 2030 (World Bank, 2005). Chinese government had invested and constructed about 2000 MSW treatment and disposal facilities in recent ten years, but the average harmless treating rate of the whole country was still at a comparative low level of 71.3% (MOHURD, 2012). About 88% of the MSW was dumped and landfilled, which resulted in the environmental pollutions of odor, underground water contamination, greenhouse gas emission and land occupation. Municipal solid waste management had become the focus of city governance due to the protest from publics for building new landfills or incinerators in Beijing, Shanghai, Guangzhou and Hangzhou city in recent years, but on the other side, the inhabitants had very low motivation on source separation, which were seemed as an effect measure for reducing and recycling municipal solid waste and lessen the waste oriented pollutions (Tsai *et al.*, 2007; Chao *et al.*, 2008).

Urban community was the key sector of municipal solid waste management; sound community-based waste management could promote waste reduction, materials separation and resource recycling, and could affect the process of waste collection, transportation, treatment and disposal (Tchobanoglous *et al.*, 2000; Colon M. and Fawcett B., 2006). Informal recycling system, sometimes it was also mentioned as the reverse supply chain, was well organized in Chinese urban communities and played an important role of recycling materials in China. The rubbish collectors sorted out the recyclables from municipal solid waste and sold them to the material recycling enterprises. The informal reverse supply chain became hard to maintain in recent years because of increasing rent costs of sorting sites and labor costs and the decreasing price of global raw materials (Zhang *et al.*, 2008). Ministry of Housing and Urban-Rural Development of China had started to explore and promote waste source separation in eight

cities (Beijing, Shanghai, Guangzhou, Hangzhou, etc.) in 2000, and expected to find out the suitable policies and executive models for China. A lots of funds from the government and other organizations had been input in the practice of waste source separation, but the sustainable and reproducible example was few. Lacking of knowledge, awareness, motivation and incentive of inhabitants, inefficient policies, education, facilities and maintenance of government were found to be the main reasons for the failure of waste source separation in China (Yuan *et al.*, 2006; Zhang *et al.*, 2008; Yang *et al.*, 2011).

Municipal solid waste management was a complex system that integrated multiple stakeholder and multi-objectives, the practice of municipal solid waste management had the uncertainty of knowledge, policies, technologies and culture of different cities, and should be adapted to local situations (Mc Dougall *et al.*, 2001). How to encourage the engagement of multiple stakeholders, especially the enterprises and non-government organizations, and how to develop an adaptive model that integrated both market mechanism and public participation were the key issues of community based MSW management. In Europe, private enterprises and non-profit organizations (NPO) were introduced in separating, sorting and transporting of recyclables, e.g. DSD in German, Eco-Emballages in France and AOO in Netherlands. They made the strategies and plans instead of the government, and played positive role in community-based recycling (Mc Dougall *et al.*, 2001). Taiwan started a recycling program entitled "Four in One" in 1997, in which the inhabitants, recycling enterprises, local government and the recycling foundation were working together, and the incentive measures to the inhabitants, pricing system and the recycling market mechanism were the key factor of this system (Tsai *et al.*, 2007; Chao *et al.*, 2008). Cases in India indicated that success of source separation program need promoting and educating from professional organizations, and private sector could involved in supplying services for waste separation and collection, and the inhabitants should pay the treating fees for throwing wastes (Rathi, 2006). Compared to above successful cases, the market mechanism was not well introduced in promoting community-based source separation in China. However, the government and the state-owned enterprises played dominated role in separating, collecting, transporting and treating the

municipal solid waste. The small recycling enterprise is also need to introduced in China to bridge the inhabitants and the centralized waste treatment enterprises (e.g. materials recovery factories, compost and fertilizer producers, incinerators and landfills), and to help the government to promote source separation.

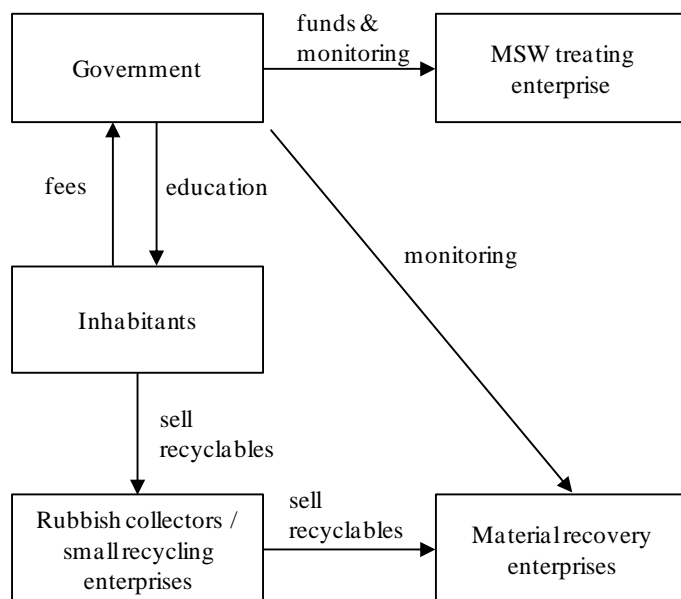
Recent literatures of community-based recycling were mainly focused on summarizing the experiences and lessons, but few researches discussed the characteristics, relationships and the inter-reactions of different stakeholders (Caniato *et al.*, 2014). The method of stakeholder analysis (SA) treating different stakeholders who involved in one project as independent roles, different stakeholders were attributed of different levels of power and interest of the studied project, and the stakeholders were connected each other by material or immaterial flows (e.g. money, good, information, contract or trust) (Vance-Borland and Holley, 2011). Stakeholder analysis gave us a framework to know the gambling process of different roles, and researches had proved that SA method was available for studying the possibility of promoting waste management policies (Caniato *et al.*, 2014). The study present in this paper analyzed the problems and the crucial reasons of inefficient source separation under normal community-based MSW management model in China, and put forward a new Waste-to-Market model that introduced the small recycling enterprise in community-based waste separation, and practiced it for one year in a community in Guiyang City. The waste reduction rate and comprehensive net benefit of WtM model were studied, and the attitude and relationships of different stakeholders in the new system were analyzed by applying SA method, and then the strategies of promoting WtM model were recommended.

## **2. Methods and Materials**

### **2.1 Normal community-based MSW management model in China**

The relationship of different stakeholders under normal community-based MSW management model in China was shown in Fig. 1. Despite the Law of Waste Pollution Control (issued in 1996) and the Law of Promoting Cycle Economy (issued in 2009) emphasized the importance and priority of source-reduction in municipal solid waste management, the mandatory regulations supporting waste source separation is still absence in China. The local

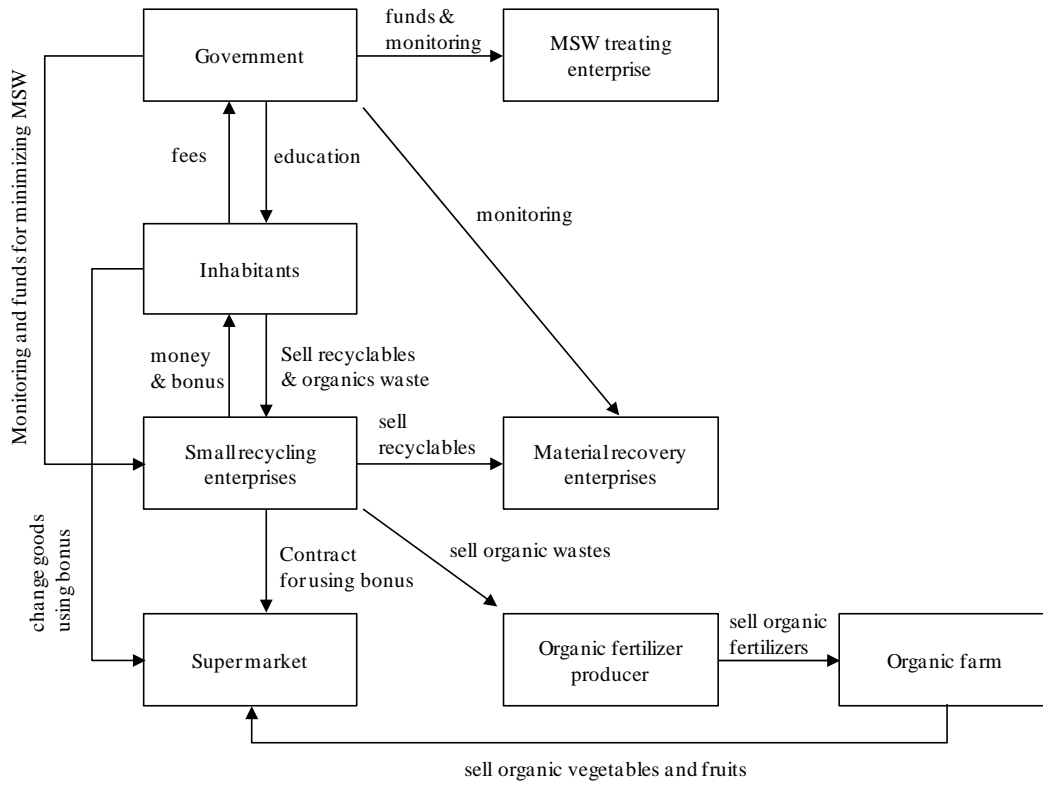
government supplied the service of waste collection and transportation, and also funded the centralized waste treatment enterprises for disposal MSW. Inhabitants paid a fixed fee of cleaning off waste, not pricing by the waste they generated, therefore they did not have enough motivation for waste reduction. Most of the Chinese inhabitants were custom to collect certain categories of recyclables, such as metals, PET bottles, aluminum bottles, board papers and electronic wastes, and then sold them to the rubbish collector or small recycling stations nearby their community. The recyclables were flowed through the reverse logistics to the material recovery enterprises, and the residues (most of them are organic waste) were landfilled or incinerated. Current difficulties of community based waste separation, recycling and management in China were summarized as follows: 1) the inhabitants lacked knowledge and mobility of waste separation and materials recycling; 2) the government did not formulate laws and policies for incentive source separation, and the comprehensive system of separating transportation, separating recycling and separating treatment was not established in most Chinese cities; 3) the market mechanism for promoting formal private enterprises to participate community based recycling is declining, thus the formal reverse supply chain could not well established.



**Fig. 1 The relationship of different stakeholders under normal community-based MSW management model in China.**

## 2.2 Waste-to-Market model

A waste-to-market (WtM) model aiming at promoting the community based recycling and sustainable waste management was put forward (see Fig. 2). WtM model integrated multiple stakeholders of governors, enterprises, inhabitants, rubbish collectors, NGOs and attempted to benefit all of them. The WtM model for community based waste management contains the following factors: 1) A reverse supply chain of organic waste management should be introduced, including: a) source separation and source collection of organic waste; b) decentralized composting or; c) compost collecting to fertilizer producers; d) compost application on organic farms; e) organic vegetable supply in supermarket; f) inhabitants who were involved in source separation receive bonus from the supermarket. 2) The private enterprises were the key sector of WtM model, they signed source separation contract with the inhabitants, supervised the behavior of separation and recorded recycling bonus to inhabitants, and bridged the reverse supply chain with logistic, supermarket, farms, material regeneration and remanufacture enterprises. Nevertheless, the private enterprises involved in the community-based recycling could receive multiple profits from materials recycling, compost recycling, bonus from supermarket and government purchased service of waste reduction. 3) The government is in charge of formulating laws and policies for incentive source separation and material recycling. The government should purchase services from the enterprise who organized community-based source separation and recycling for waste reduction. And the government also should propagate and educate inhabitants for contributing in source separation.



**Fig. 2 The relationship of different stakeholders under community-based waste-to-market model for sustainable municipal solid waste management.**

### 2.3 Reduction rate and economic benefits

The reduction rate and the economic benefits were chosen as the indicators for comparing the WtM model and normal model. The data of total municipal solid waste generation, collected organic wastes, collected recyclables (metals, PET bottles, aluminum bottles, board papers, other papers, etc.) and the residues were recorded by wet weight (kg), the reduction rate was calculated use following formula. And the data was recorded from May 13<sup>th</sup>, 2012 to June 27<sup>th</sup>, 2013.

$$r = 1 - \frac{W_{disposal}}{W_{total}}$$

Where,  $r$  is the reduction rate of municipal solid waste in the community;  $W_{disposal}$  is the weight of municipal solid waste that need to be transported to the landfill or incinerator for further disposal;  $W_{total}$  is the weight of municipal solid waste that generated from the community.

The cost of labor, facilities, plastic bags using for packing separated waste were provided by the Guiyang Gaoyuan Solid Waste Recycling Company, and the investigations were completed to get data of cost and benefit from the centralized waste treatment enterprises, organic fertilizer producer, organic farm, supermarket and the material recovery enterprises. The local government, Environmental Protection Agency was also been interviewed to get the data and information of MSW governance, costs and benefits.

#### **2.4 Stakeholders analysis method**

The first list of stakeholders and interviewees were formed base on the information from local municipal solid waste management experts, the stakeholders list was upgraded when we did more investigations. The method of stakeholder analysis (SA) is applied for systematically gathering and analyzing qualitative information to determine whose interest should be taken into account when developing a program (Schmeer, 1999). A questionnaire of characteristics of the stakeholders in community-based recycling was shown in Table 1, the questionnaire system was referred by Caniato (2014). Scores system was used to interview different stakeholders, and the characteristics of stakeholders included interest and power, which represented the willingness and the possibility for the stakeholders to develop the WtM model in the community. In total, 8 kinds of stakeholders were interviewed in our studied case, and each interview was conducted for about one hour and the attitudes on source separation, household recycling and the new WtM model were recorded. According to previous research of stakeholder analysis in the field of waste management (Caniato *et al.*, 2014), the stakeholders were definite as three different groups: (1) government (local Environmental Protection Agency, policymakers and governors); (2) inhabitants (the inhabitant living in the studied community); (3) private sector (MSW treating enterprises, e.g. landfill, incinerator; small recycling enterprise; material recovery enterprises, e.g. metal glass plastic regenerating industries; organic fertilizer producer; organic farm; super market).



**Table 1 A questionnaire of characteristics of the stakeholders in community-based Waste-to-Market model.**

| Characteristics of stakeholders   | Scores and Levels   |
|---|---|
| Interests: The self-reported level of interest of the interviewed stakeholders who will involved in community-based Waste-to-Market model.  | 3 Level<br>1. No or minimum interest (1-3)<br>2. General interest (4-7)<br>3. Primary interest (8-10) |
| Power: The self-reported level perception of power, based on the availability to access to resources (money, labor, regulation), and possibility of changing the current balance. | 3 Level<br>1. Low power (1-3)<br>2. Medium power (4-7)<br>3. High power (8-10)                        |

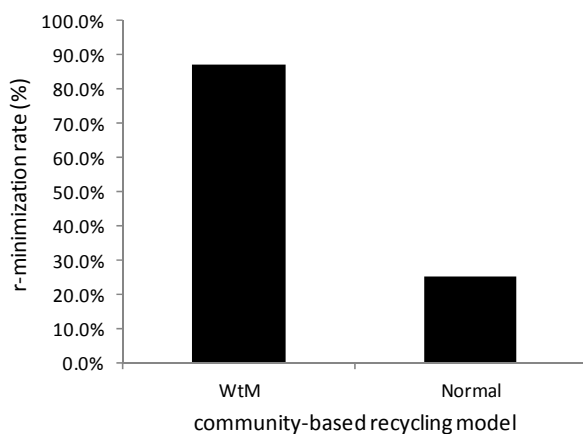
## 2.5 Case study

The studied case Zhenhua Community was located in Wudang District, Guiyang City, Guizhou Province, in the Southwest China. In Guiyang City, the total generation of municipal solid waste was 1580 ton per day, 0.58 million ton per year, while the total capacity of the two landfills was 1400 ton per day, and the harmless treatment rate was 88.6%. The government promoted source separation five years ago, but the source separation rate of municipal solid waste was extremely low. Local government of Wudang District had issued “*Implementing Scheme of MSW Source Separation in Wudang District*” in 2013 to promote the Waste-to-Market model that developed by the authors. In this document, the government agree a fund of 160 RMB/t(MSW) for minimization the municipal solid waste through the recycling program. The program was started from 13<sup>th</sup> May, 2012 to 27<sup>th</sup> June, 2013, and there were 82 households in the studied community, 76 households (92.7%) agree to engage to the demonstrating program.

## 3. Results and Discussion

### 3.1 Minimization rate of different models

According to the recorded data from the studied community, the 17.18 ton municipal solid waste was generated in one year, in which 12.44 ton organic waste was separated (72.4% of the total MSW) and 2.56 ton recyclables (metals, PET bottles, aluminum bottles, board papers, other papers, etc.) was collected (14.9% of the total MSW). The small recycling enterprise record the weight of separating collected organic waste and recyclables of each household, and gave them a bonus (recorded in a specified card). The bonus was 0.05 RMB.kg<sup>-1</sup> for organic waste and 0.1 RMB.kg<sup>-1</sup> for recyclables. And then the organic wastes were sold to organic fertilizer producer, while the recyclables were sold to material recovery enterprises. The residue waste needs further treatment and disposal by landfill was 2.18 ton, thus the waste reduction rate under WtM model was 87.31%. Compared to normal recycling model, inhabitants only sold the recyclables to the rubbish collectors or recycling stations, the waste reduction rate was only 25.38%. Under WtM model, the small recycling enterprise had signed an agreement with each household for recycling, and gave bonus of separating organic waste; therefore the recycling rate in our experimental period was high. The proportion of organic waste is high in China because of the food material and cooking custom, thus the separating of organic waste played very important role in community-based MSW management.



**Fig. 3 Comparison of minimization rate of different recycling models for community-based municipal solid waste management**

### 3.2 Cost-benefit efficiency

The changes of net benefits of different stakeholders under WtM and normal model were compared in Table 2. Among all the stakeholders: inhabitant, small recycling enterprise and supermarket obtained positive benefits; government and MSW treating enterprise obtained negative benefits; and organic fertilizer producer, organic farm and material recovery enterprises did not change in benefits. Despite the increasing cost of maintenance the new system, the net benefit of the waste managing system under WtM model obtained a net positive benefit of 18.3 RMB.ton<sup>-1</sup>. It is mainly because the organic waste, which was the dominant component of MSW, could be recycled and composted to be the organic fertilizer, and the urban ecological loop of urban eco-system was closed.

**Table 2 Cost and benefit of the stakeholders under different MSW management models of the studied community (RMB.ton<sup>-1</sup>.yr<sup>-1</sup>; 1 RMB = 0.117 EUR)**

| Stakeholder                  | Normal | Noraml  | WtM   | WtM     | Benefit<br>change |
|------------------------------|--------|---------|-------|---------|-------------------|
|                              | cost   | benefit | cost  | benefit |                   |
| Government                   | 124.7  | 0.0     | 158.3 | 0.0     | -33.6             |
| Inhabitants                  | 318.5  | 14.9    | 318.5 | 51.1    | 36.2              |
| Small recycling enterprise   | 46.6   | 59.6    | 338.9 | 373.1   | 21.2              |
| Material recovery enterprise | N/A    | N/A     | N/A   | N/A     | 0.0               |
| MSW treating enterprise      | 20.0   | 35.0    | 2.5   | 4.4     | -13.1             |
| Organic fertilizer producer  | 173.8  | 231.7   | 173.8 | 231.7   | 0.0               |
| Organic farm                 | N/A    | N/A     | N/A   | N/A     | 0.0               |
| Super market                 | N/A    | N/A     | N/A   | 7.7     | 7.7               |
| Total                        |        |         |       |         | 18.3              |

In normal model, the government only paid 146.5 RMB.ton<sup>-1</sup> MSW to the transportation

and the MSW treating enterprises, while in the new WtM model, the government paid for 160 RMB.ton<sup>-1</sup> MSW to the small recycling enterprise for the government purchase service of waste reduction. In total, the government had a net negative benefit of 33.6 RMB.ton<sup>-1</sup> MSW when the new WtM model was adopted.

The inhabitant paid a fee of 72 RMB per household for cleaning off the MSW, this fee did not differ under normal model or under WtM model, but the inhabitant only obtained the benefit from selling the recyclables for 100 RMB.ton (recyclables)<sup>-1</sup>, but they obtained a new bonus of separating organic waste for 50 RMB.ton(organic waste)<sup>-1</sup>, that's the reason why the inhabitants obtained a net benefit of 36.2 RMB.ton<sup>-1</sup> MSW under the WtM model.

The small recycling enterprises had a lower labor cost in normal model, they only need to hire or buy the recyclables from the rubbish collector, who did not need special training; but in WtM model the small recycling enterprise hired a formal staff for a higher labor cost of 3 RMB per household per month, and the extra cost of specified plastic bags (3 RMB per household per month) and a weighing and recording facility (7000 RMB for each community and discount for ten years) should be included. The small recycling enterprises obtained extra benefits of selling organic wastes and funding from government for waste reduction, thus the small recycling enterprise obtained a net benefit of 21.2 RMB. ton(MSW)<sup>-1</sup> in our studied case.

The centralized MSW treating enterprise (landfill in this case) disposed MSW for a quota of 35 RMB. ton(MSW)<sup>-1</sup>, the organic waste was included in the normal model, but the organic waste was separated and flowed to organic fertilizer producer in the WtM model. The net benefit decreased 13.1 RMB. ton(MSW)<sup>-1</sup> for the centralized MSW treating enterprise due to the sharp decrease of input MSW in the WtM model.

Supermarket issued a contract of small recycling enterprise for allowing inhabitant shopping with the bonus, which was obtained from separating organic waste and recyclables, and the total business volume of supermarket increased. The net benefit of supermarket increased 7.7 RMB. ton(MSW)<sup>-1</sup> when the average profit of supermarket was counted as 15%.

### **3.3 Stakeholder analysis**

According the reviews of eight different stakeholders involved in WtM model, and the

attitude for each stakeholder was as follows:

Government: the average funding for waste reduction to small recycling enterprise could not be too much higher than  $146.5 \text{ RMB} \cdot \text{ton}(\text{MSW})^{-1}$ , which was funded to the collecting, transporting, treating and disposing stakeholders in normal model. Finally, the government and the small recycling enterprise signed a contract of  $160 \text{ RMB} \cdot \text{ton}(\text{MSW})^{-1}$  for waste reduction, which was the limitation of the government.

Inhabitants: 1) the recyclables was prior selling to the small recycling enterprise because the membership and the agreement between them; 2) bonuses of separating organic waste and recyclables were accepted by inhabitants in  $0.05 \text{ RMB} \cdot \text{ton}(\text{organic waste})^{-1}$  and  $0.1 \text{ RMB} \cdot \text{ton}(\text{recyclables})^{-1}$ ; 3) if the bonus cannot easily used in nearby supermarket, most of the inhabitant will stop to separating organic waste.

Small recycling enterprise: 1) source separated organic waste should be accepted as a raw material for compost by the organic fertilizer producer; 2) local government should paid for the waste reduction as a government-purchase-service, and should not lower than  $160 \text{ RMB} \cdot \text{ton}(\text{MSW})^{-1}$ ; 3) supermarket agree to sign contract of using bonus; 4) the net benefit of small recycling enterprise could not be negative.

Centralized MSW treating enterprise: the WtM model only can be accepted when the total profit will not reduce, otherwise they will oppose promoting this model in a large scale.

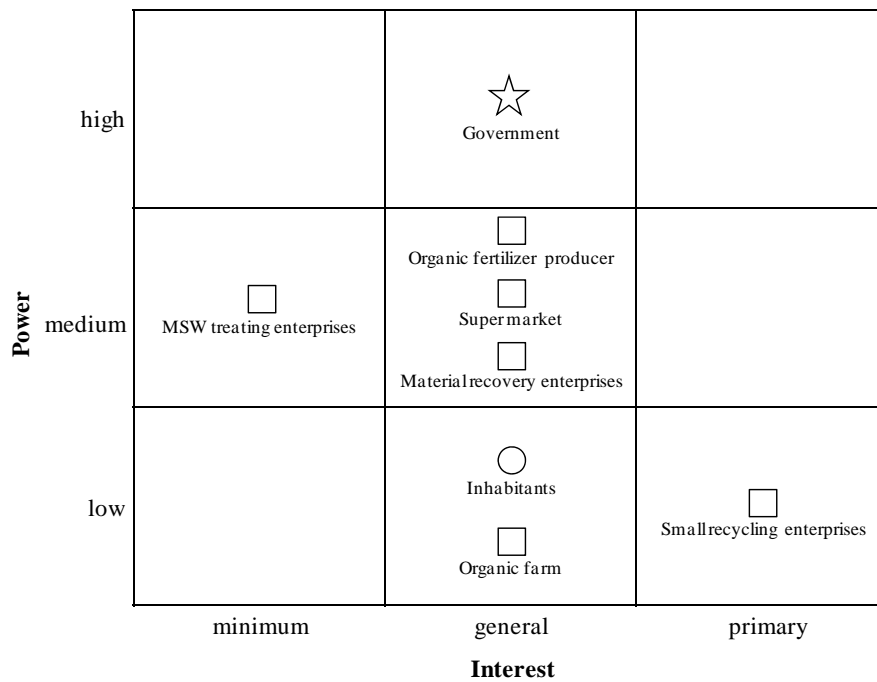
Material recovery enterprises: the ordinary recyclables such as metal, PET bottles, aluminum bottle, board paper, etc. will be accepted according to the market price.

Organic fertilizer producer: the organic waste collected by small recycling enterprise should reach the state standard quality (limitations for organic matter, nutrients, heavy metals, etc.), other municipal solid waste, especially some harmful waste, could not mixed in the collected organic waste, and the price of organic waste as raw compost material could not be higher than  $240 \text{ RMB} \cdot \text{ton}^{-1}$ .

Organic farm: the organic fertilizer produced by uncontaminated organic wastes was acceptable, but the quality of the compost should strictly reach the state compost quality, and the price of compost could not higher than  $800 \text{ RMB} \cdot \text{ton}^{-1}$ .

Supermarket: the bonus was accepted to use in the supermarket because the increase of customers and business volume, an advertising effect also could be obtained by participate in WtM model. The small recycling enterprise should pay equally as the inhabitants consumed by bonus. The organic vegetables and fruits cultivated by waste compost were accepted if they could certificate by Agriculture Department.

Results of the power and interest of different stakeholders were shown in [Fig. 3](#). For promoting WtM model in the studied city, government had the high power for introducing a new system, but the government had the general interest for it. It is because that promoting WtM model had two sides in the consideration of government, for one side, promoting WtM model could receive achievements in one's official career, and on the other side, the waste collection and treatment system was prior to be stable and safe. The centralized MSW treating enterprise also had a medium power because of the state-owned background and the long time cooperation with the local government, but if the WtM model was promoting in a large scale, the profit of them will sharply reduce, thus they had the minimum interest in the new system. Inhabitant, organic fertilizer producer, organic farm, supermarket and the material recovery enterprises had the general interest of promoting WtM model, because all of these stakeholders benefit a lot in WtM model, but the potential benefits were not higher enough for them to have extreme motivation for changing. Among all stakeholders, the small recycling enterprise had the primary interest of promoting WtM, because it will obtain a higher profit and realize the self-value of them. But the small recycling enterprise had the low power to change the current community-based MSW management system.



**Fig. 3 Stakeholder analysis of community based waste-to-market model for sustainable municipal solid waste management**

### 3.4 Strategies for promoting WtM model

Introducing the small enterprises, small organizations and the market mechanism was proved to be effective in promoting the community-based source separation. It also could be the key factor for a higher recycling rate in developing countries, in which the public knowledge and governance capacity should be strengthened (Hung *et al.*, 2007). In our case, the new WtM system introduced a small private enterprise for promoting and monitoring the source separation, and the waste reduction rate was increased in one year, and the organic waste (72.4% of the total MSW) could be cycled in human society. Thailand had conducted a similar research as ours, they had promoted a model of “exchange egg with waste (1 egg = 1.35 recyclables)” to incentive the inhabitants to participate the source separation. Although the recycling rate increased from 37.7% to 58.6%, but this program was estimated un-sustainable because of the rubbish collector was excluded to the program, and the government had no continuous education and development plan in the case (Mongkolnchaiarunya *et al.*, 2005). Compared to Thailand case, our demonstrating project may also face the similar problems if the government

stops educating inhabitants or never fund the small recycling enterprise for waste reduction. But in our case, we did training to rubbish collectors to transform them to formal staff of the small recycling enterprise, and the income of rubbish collector could increased 3 times and the living quality was also improved. Sustainable municipal solid waste management and policies require participation of all involved parties and various stakeholders, and the integration of public- private sector- community could obtain a win-win model in municipal solid waste management (Zurbrugg *et al.*, 2005; Zotos *et al.*, 2009). In our case, introducing a new WtM model and the new private sector seems to bring threats to the traditional MSW treating enterprises, but on the other side, the source separation of the organic waste, which was ordinary with high moisture content and low heat value, could be also increase their long-term economic benefits. For example, removal of wet organic waste could reduce the operating cost for incinerators and could transfer more energy from burning waste; while reduction of organic waste could prolong the potential operating years and reduce the cost of treating the leachate. Therefore, the cooperation between the small recycling enterprises and the centralized MSW treating enterprises was still possible for benefit the both.

The policies and regulations from the government was another important factor for promoting WtM model in community scale. Municipal solid waste pricing system, sometimes called pay-as-you-throw (PAYT) program, appears a positive effect on promoting waste source separating and recycling performance. The implementation of pay-as-you-throw (PAYT) programs reduced the amount of residual waste generated by 20% to 30% in Japan (Sakaria *et al.*, 2008). The successful “Four-in-one” recycling model was also based on the PAYT system that charged by different size of the plastic bags used for packing mixed waste (Tsai *et al.*, 2007; Chao *et al.*, 2008). Minnesota case indicated that variable pricing of waste disposal increases the rate of recycling, enactment of recycling ordinances and cumulative expenditures on recycling education are also found to be effective measures to increase recycling rate (Sidiq *et al.*, 2010). However, PAYT system was not always effective, studies in Flanders, Belgium showed that using a weight-based pricing system appears to have no impact on efficiency,



instead member of a waste collection joint venture, or that subscribe to a voluntary agreement to reduce MSW at the highest ambition level, which were also conducted in our studied case (Jaeger *et al.*, 2011). China government only imposed a fixed fee (48 to 72 RMB per household per year) to the inhabitants for cleaning off the waste, or the waste treatment fee was imposed according to the consumption volume of fresh water in some cities, therefore the inhabitant did not be directly “punished” for the quantity of throwing waste. In the future, if the Chinese local government could promote PAYT program, the inhabitants will had more incentive on reducing the waste. Moreover, the operating cost of the small recycling enterprises (e.g. fewer bonus and less monitoring input) will reduce, and then the WtM model could be promoted in more cities.

#### **4. Conclusion**

A community-based Waste-to-Market model was put forward, designed and practiced in this study to solving the current problems of inefficient source separation in China. WtM model, which integrated the concepts of the bonus for separating organic wastes, government funds for MSW reduction, introducing small recycling enterprise for promoting source separation of organics, could increase the waste reduction rate and the comprehensive economic benefit and could close the ecological loop of urban ecosystem. The stakeholder analysis showed that the centralized MSW disposal enterprises had minimum interest and may oppose the new recycling system; while the small recycling enterprise had the primary interest but low power in promoting WtM model. Policies and regulations from the government play the most important role in promoting the WtM model.

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