

**McMaster University School of Engineering Practice
MEPP Inquiry**

**A Comparative Study of Qingdao, China and
Hamilton, Canada from a Municipal Solid
Waste Management System Perspective**

**Submitted in partial requirement for the Master's degree in
Engineering and Public Policy**

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ABSTRACT

In China, Municipal Solid Waste (MSW) problems are growing fast. The annual waste generation increasing almost 10% per year and the population of municipalities is expanding, but sanitary landfill and recycling facilities are still rare to see. With rapid economic development, it is even harder to achieve waste reduction, reuse and recycling than developed countries which have significantly mediated these problems. Learning from successful experiences in Canada, an Integrated solid Waste Management (ISWM) approach is deemed to be an improvement over China system. This inquiry reviews the current situation of MSW management system in China and Canada. To better illustrate the complexity of ISWM systems, the inquiry takes systematic comparisons of two cases, Qingdao in China and Hamilton in Canada. From reviewing of system structure, environmental impacts, public participation and legislation, the inquiry drew lessons from the system's development and management in Hamilton and they will benefit the implement of a sustainable MSW management system in the city of Qingdao.

1. INTRODUCTION

China faces a serious challenge in managing its MSW while maintaining its economic development. In 2004, Municipalities in China generated about 190 million tonnes MSW, and the amount of it could reach 480 million tonnes by 2030. China has become the world's largest MSW generator in a rapid speed that no country has ever experienced ([East Asia Infrastructure Department World Bank 2005](#)). Moreover, increasing waste generation rate greatly impacts the lifestyles of people, economic development and environmental protection. To deal with such a pressure, the Chinese government started to implement an integrated approach for MSW

management system. For instance, a brand new concept, circular economy, has been brought out. Under this concept, waste prevention and recycling have been emphasised (Nailing 2006). Before that, the State Council passed legislation to ' establish waste separation and collection systems and continuously improve renewable resource recycling systems,' (State Council 2005). Chinese government, in political level, began to move towards the top of the waste hierarchy. This waste management strategy is focusing on 3 Rs principals which refer to reduce, reuse and recycle (European Commission 2012). Waste hierarchy is illustrated in Figure 1. As the focus of China's MSW management is shifting from just waste disposal and final treatment to the overall process, it leads to a demand for an integrated management system for the overall process and the joint efforts of different stakeholders.

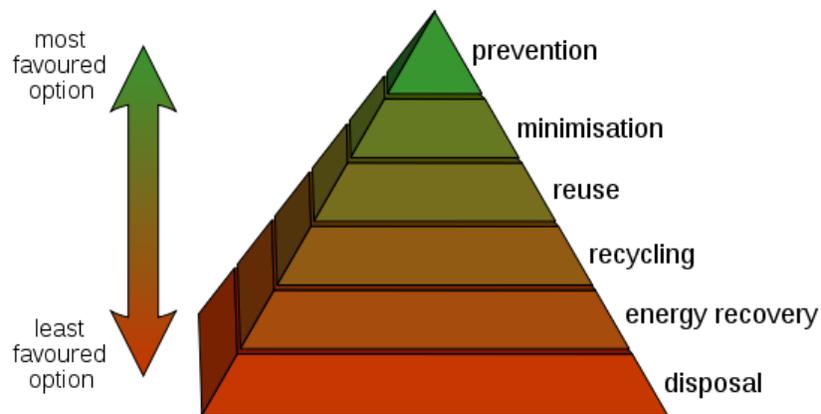


Figure 1. Waste hierarchy (Zero Waste Europe 2013)

Moreover, China requires an integrated system approach for MSW management in practice to achieve sustainability of the waste management system based on lessons drawn from developed countries(Wilson 2007). The Integrated Waste Management (IWM) has been widely adopted as an effective way for developed countries and also been highly recommended for developing

countries (Dai H 2004). The IWM can be referred as a holistic approach which manages waste in an economical, environment friendly and socially acceptable way. It starts from the entire solid waste stream with a range of different treatment options at a local level (McDougall 2001). In 2006, Seadon further interpreted the IWM as the integration of (I) multiple agents, (II) multiple tools, (III) wastes treatments in multiple medias, (IV) multiple options for wastes treatment into a single medium (atmospheric, aqueous and solid waste) (JK 2006). For these comprehensive characteristics of IWM, the application of the IWM approach is a great challenge for those developing countries which have limited resources, expertise and accurate data (International Solid Waste Association, United Nations Environment Programme 2002). In order to support the application of the IWM approach on a city wide basis in a developing country, it would be helpful to conduct a comparative study of an IWM system for a city in a developed country and a system from a city in a developing country with comparable city size and/or population density. The experiences and lessons could be easily drawn and utilized to build a framework for successfully adopting an IWM system in China. This inquiry seeks to compare the application of the IWM approaches on a municipality in a developing country and an example from a city wide in a developed country. With this target of a holistic comparison of IWM, I employ two cases which are City of Hamilton in Canada and City of Qingdao in China to compare and discuss.

2. BACKGROUND

2.1. Background Information of Hamilton in Canada

The city of Hamilton is located in the southern Ontario, Canada. The city covers a 1,138.11 km² land size with an elevation of 324 m. Hamilton has a humid-continental climate which is

characterized by changeable weather patterns. Hamilton is located on an embayment at the southwestern corner of Lake Ontario. With an escarpment dividing upper and lower parts of the city, it results in noticeable disparities in weather over short distances. However, Hamilton's weather is moderate compared with other cities of Canada. The summers are usually warm to hot and humid, and winters are normally cold but with frequently thaws. For its southerly location, it receives quite a bit of snow. The snowfall averages 126 cm (50 in) from year to year variation. The city of Hamilton is 10th largest city in Canada with a population density of 465.4 people per kilometer at 2011 ([Statistics Canada 2013](#), [City of Hamilton 2013](#)). In Hamilton, population density is relatively low, and townhouses are the major residential buildings. Townhouses are suitable for curb-side-pick-up services because of their large space for storing multiple waste bins and setting them out at the curb. Similar services, however, are not quite effective for apartments. Waste generated from an urban area was 238,000 tons in 2011. About 49% of this waste was diverted by various programs, including Blue Box Composting and other programs that divert hazardous wastes (Figure 2). Final disposal method inevitably remains landfills. Hamilton has a large disposal capacity with approximately 20-year landfill at the current pace of landfill ([Vidler 2012](#)).

2.2 Background Information of Qingdao in China

Qingdao is located on the south facing coast of the Shandong Peninsula, Shandong province, eastern China. The total jurisdiction area of the city occupies 10,654 km². The highest elevation in the city is 1,333 m above sea level. Qingdao's climate lies in the transition between the humid subtropical and humid continental regimes. The summers are generally hot and humid with an

August average of 25.3 °C. The winters are cool to cold and windy, but normally dry, with a January average of - 0.5 °C. Qingdao is comprised 10 districts. This inquiry only focus on five urban districts where Qingdao municipal government unifies their MSW management duties. In these five urban districts, approximately 3 million people reside in the 1411.25 km² area ([Qingdao Government 2013](#)). In contrast to Hamilton, its population density, 2,642 people per kilometer, is much higher. Its major residential building is apartments whose indoor and outdoor storage areas are very limited. It is estimated that approximately 66,170,000 tons of waste are generated from this area per year or 1.05 kg per capita per day ([Dai 2013](#)). Residential wastes account for approximately 80% of total waste stream, mainly the organics. About 5% of the waste stream, mainly metals, plastics, beer bottles and discarded electronic waste, is sold directly by residents to informal agents such as itinerant junk-buyers and redemption points. Some valuable items remained in the waste stream are diverted by sanitary works and scavengers during collection and landfill processes. Currently, landfill remains the major disposal method but Dalian faces a severe shortage of landfill space. The only landfill site, Xiaojianxi site, for urban area in Qingdao will close in 5 years at the current pace of landfill ([Wenxia Xie 2012](#)). The waste stream is showed in Figure 3.

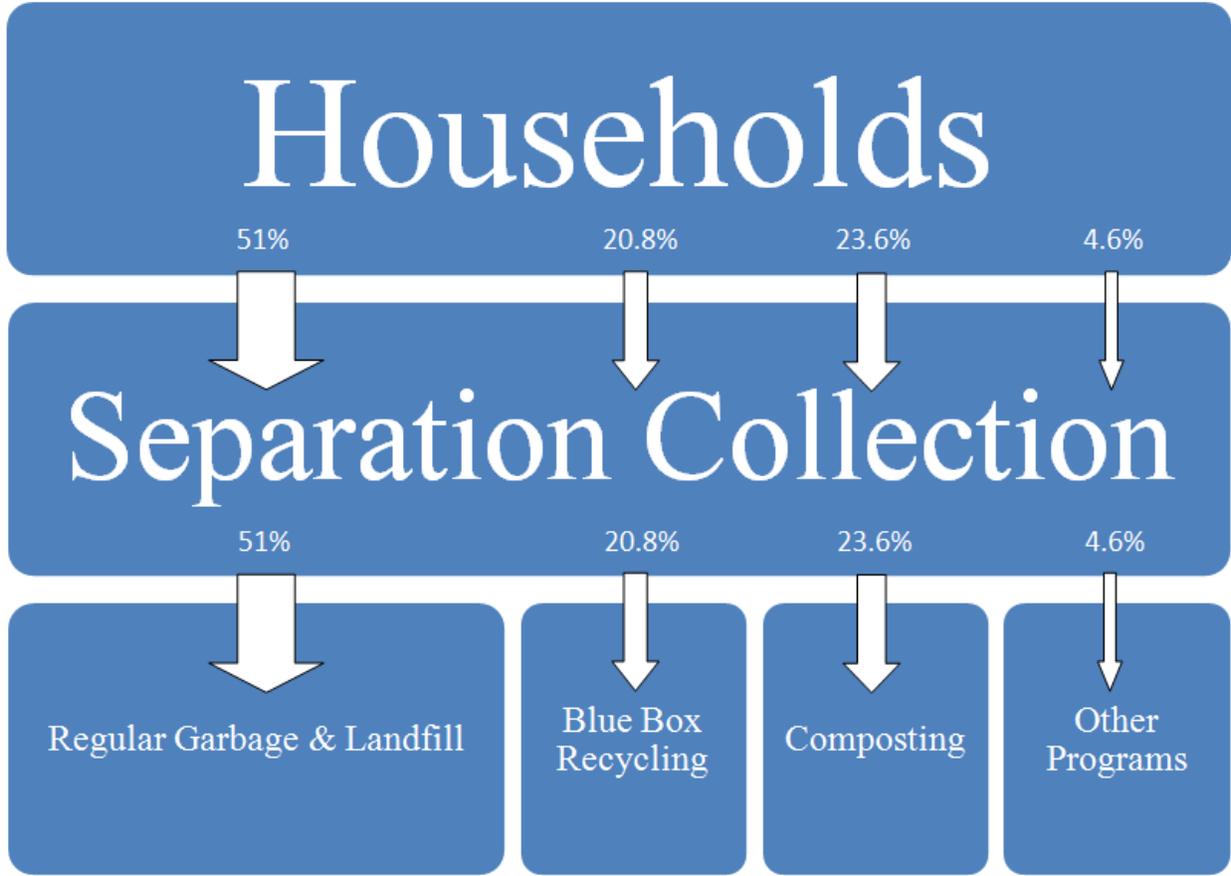


Figure 2. The waste stream in the City of Hamilton (based on the 2011 data) (City of Hamilton 2012).

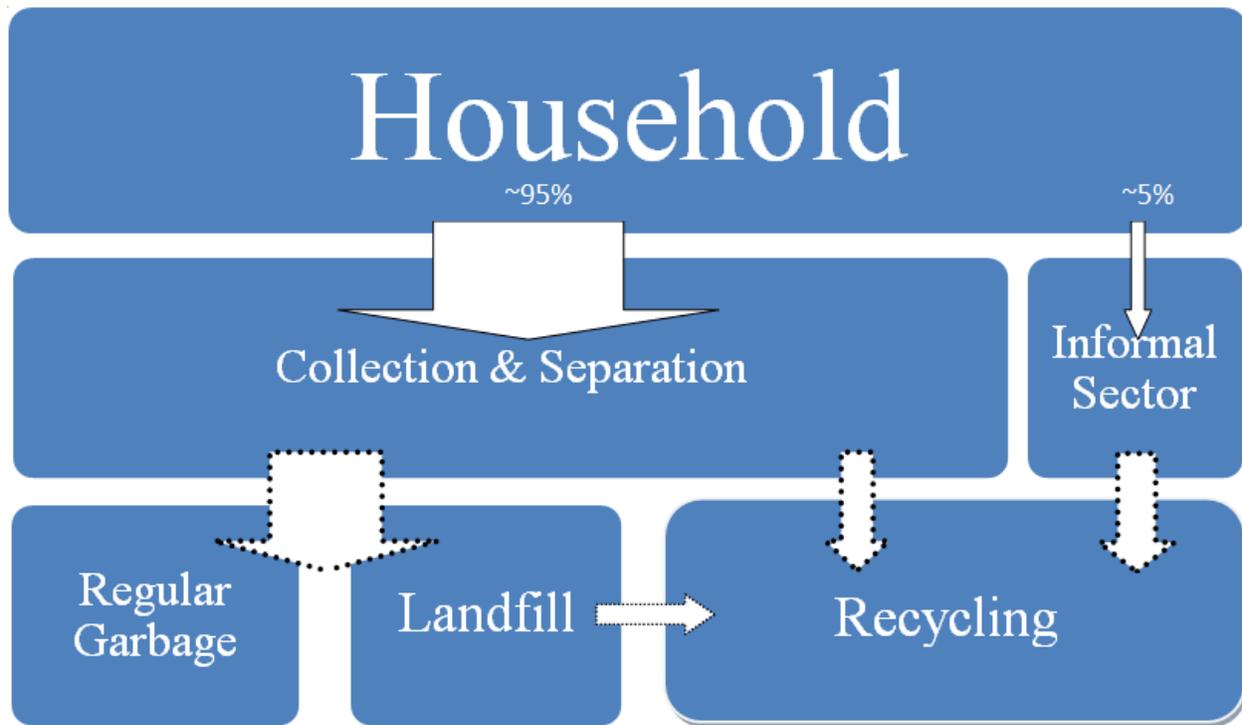


Figure 3. The waste stream in the City of Qingdao (note: the dotted arrow represents that reliable figures of the indicated waste stream are absent) (Dai 2013).

From the background information of two cities, they have little difference on the climate and the geographic size but a big difference on the population density. Similar climate makes the humidity of the waste comparable. The geographic sizes of two cities' urban areas are almost same which will make a big gap between two cities' management of MSW. Especially, the geographic size of a city makes a big difference on the waste transportation (Ontario Municipal Benchmarking Initiative 2005). The population density of Hamilton is much smaller than that of Qingdao. The total volumes of waste generated are definitely different. However, the weight of waste generated per person are comparable. The inquiry does comparison of the two cases from three aspects. First of all, to give the whole picture, it exams the structures of the MSW management systems in Hamilton and Qingdao. Secondly, it discusses the aspects of waste

management components namely public sector and private sector and their interactions. Thirdly, the inquiry undertakes comparison study of two cases from legislation and social aspects.

3. STRUCTURE

In the case of Hamilton, separation is a basic feature. Residents separate regular wastes, yard wastes and recyclables then these wastes are picked up weekly at the curb-side. Service delivery is also separated. The City of Hamilton developed a competitive model (blending public and contracted waste collection services) for service delivery. Such a public/private service delivery model would encourage competition and therefore, improves service quality and efficiency yet retain public sector jobs (Goodger 2011). While the municipal government is in charge of administration, the City of Hamilton takes the responsibility of supervision, organization, mediation and public education. As most municipalities in Ontario and even in whole Canada share a similar structure of MSW management system (Figure 4), this structure encourages enterprises to specialize in certain services and to provide better services.

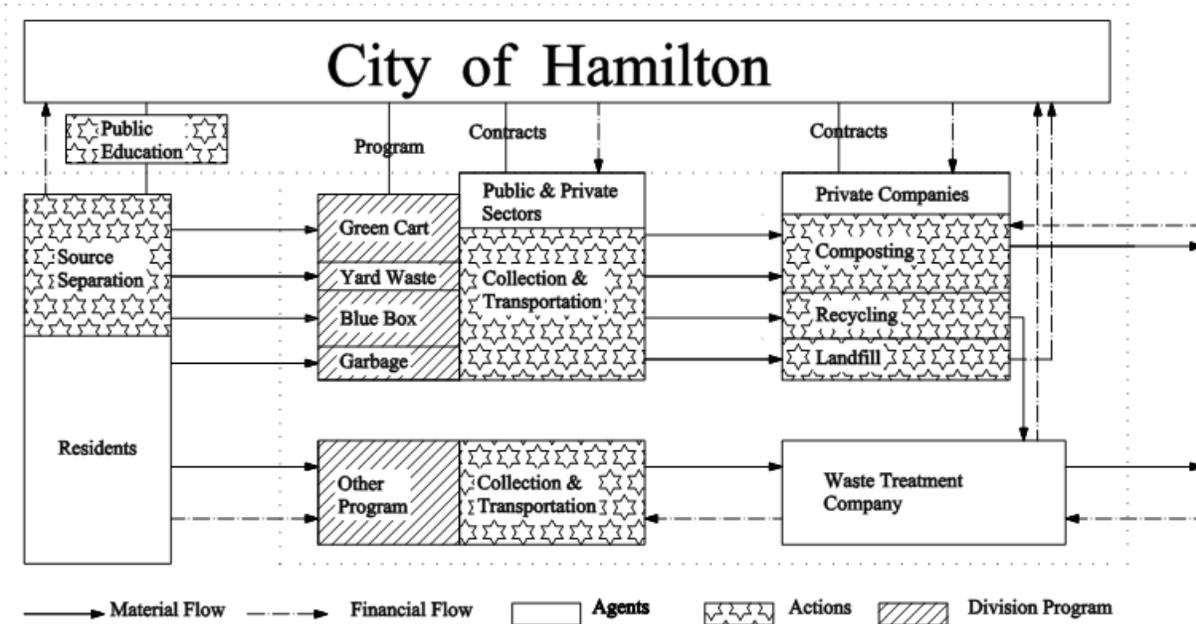


Figure 4. The waste management system in the City of Hamilton (City of Hamilton 2012).

Such a system structure would also benefit expansion. Especially, when new programs are launched, the programs in the system can share the existing infrastructure in order to be most cost-effective. Besides, more types of wastes diverted into existing programs could also follow the same way. For instance, a recent new program, the Green Cart program, which was designed to divert organic waste was launched in April 2006. This new program is similar to the existing program which deals with the yard waste. By sharing infrastructures like transportation and treatment facilities, the whole system introduces minor changes in public behavior and saves budgets.

Good system management makes the system work effectively. A good system approach can be treated as a system that has vision and stability. With a continuous improvement strategy, the City of Hamilton has already had good system management for waste management. In the

strategy, long and short-term goals have been well defined and been put in a strategic framework. In the process of management, the essential data will be collected and utilized to monitor progress and improve the system. In the political framework of Hamilton, all city staff are paid employees and are not appointed or elected by government. Therefore, the city staff including senior staff are free of influence and independent from the political process. A political framework like this avoids unnecessary interference and provides stability for the waste management system (Steblyn 2008). Moreover, the City of Hamilton owns the landfill, the key facility in the waste management, in order to achieve long-term stability (City of Hamilton 2012).

In Qingdao, the system is much more complex than the system in Hamilton (Figure 5). The administration of MSW management and the service delivery is not separated. Both of them are under control of the local government whereas the recycling service is delivered by informal agents. Junk-buyers redeem recyclable wastes at the redemption points, and scavengers pick up wastes at landfill sites. Financial flows are flowing in the opposite direction with the waste stream. In another word, recycling is fully profits motivated. Moreover, the informal agents are widely scattered and largely unauthorized, so it is hard to regulate them with certain standards to divert more items that have lower remaining market value. Junk-buyers and scavengers who live on selling recyclable wastes to informal agents only collect the high remaining market value wastes (Li 2002).

Recently, Qingdao made efforts to improve waste diversion. In 2012, a treatment facility specialized in composting organic waste from kitchens has started to build. This facility could treat 200 tons kitchen wastes per day once it is put into operating. It could separate the waste oil

and compost the rest of them. From estimating, it could daily generate 6 tons oil, 30 tons residues and 16,000 m³ Biogas in fully operation. However, the building treatment facility is largely independent of the existing system. Usually, the kitchen wastes will not be separated from regular garbage and end up into landfill. The way to properly regulate the separation of kitchen wastes still remains a question without clear answers ([Wang 2013](#)). In practice, this program also faces several challenges. First, it needs the resettlement of the policy of waste in Qingdao. The kitchen wastes should be separated from the regular garbage. The effective way to make residents do that is legislation and regulation. Second, the local government need to arrange independent transportation for kitchen wastes. Without the transportation designed for kitchen wastes, the cost of separation for kitchen wastes will highly increase. At the same time, the value of wastes after separation will decrease. As a result, the program takes high risk of failure.

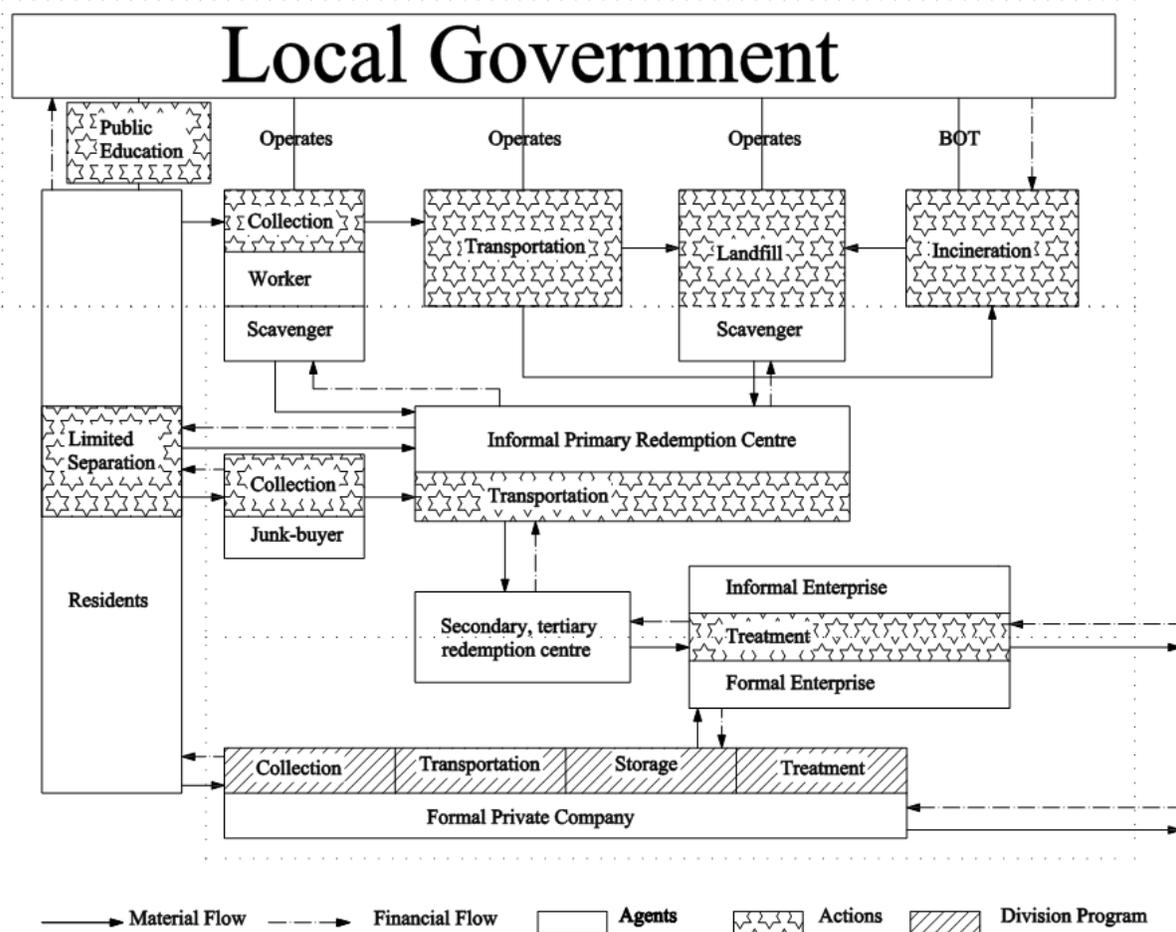


Figure 5. The waste management system in Qingdao. Source: interviews with the manager in Qingdao Environment and Sanitation Bureau and Qingdao Construction Bureau.

Refer to the good system management, it is really poor and has not been draw enough attention by the local government in Qingdao. It is rare to see well defined strategy for MSW management in Qingdao. In the strategic sanitation plan of the city, it broadly mentions possible actions to improve the waste management without specific goals and a framework to achieve the goals (Qingdao Government Affairs Online 2013). Data used to monitor and improve the waste management system is scanty. Sometime, long-term waste management projects can be interfered by the highly politicized administration of the city. The lesson we drawing from

Hamilton provides a clear pathway and stability to establish a sustainable waste management system in Qingdao. That is drawing up a waste management plan for the city, setting up specific goals and making a framework to achieve the goals. From the experience of Hamilton, the local government of Qingdao needs to carefully assess the available infrastructure and all waste produced in the city before having a sustainable waste management system established. The city also should put a system in place to collect regular data from the waste management services monitoring which could be utilized to assess the performance of the waste management services annually to and identify possible improvement for the system. The training of staff is crucial to institute a good management system. All city staff should be highly motivated to take challenges in the waste management and able to provide practical solutions.

4. COMPONENTS

4.1. Public Sectors

In Ontario, regulations and policies for waste management are provided by the provincial government. Key legislation of them is 3 Rs Regulations ([Ministry of Environment 1999](#)) and Waste Division Act (WDA). WDA was enacted in 2002, and its goal is 'to promote the reduction, reuse and recycling of waste and to provide for the development, implementation and operation of waste diversion programs (section 1)'. In 2007, Waste Management Project Regulation was passed to set up a new environmental assessment process that benefits small communities, recycling project and new technologies. Moreover, a goal of 'diverting 60% of Ontario's wastes from disposal by the end 2008,' ([Ministry of the Environment 2004](#)).

In addition to regulations and policies, governments also direct the waste planning. To support the development, implementation and operation of wastes diversion programs for materials including blue box materials, used tires, electronic wastes and household special waste, Waste Diversion Ontario was formed at the provincial level. At the municipal level, municipal governments is responsible for wastes management plans preparation and have them reviewed and revised ([City of Hamilton 2012](#)). Moreover, municipal governments often need to investigate for new programs. For instance, the City of Hamilton referenced similar organic waste diversion program in Regions of Halton and Halifax before the Green Cart program. Obtaining feedbacks of residents in program covered areas at the first phase of the program is also the municipal governments' duty.

In China, no distinct regulations or policies for management of MSW, but regulations and policies on recycling and recovery do exist. Local governments leave their focus on safe disposal rather than increasing the recycling rate. This was because unsafe waste disposal is treated as a high risk to public health. Moreover, local governments also lack experience and expertise in waste management and planning. In Qingdao, the government only has plans on waste treatments and disposal system but no plans on management system. Because no city has ever operated a successful diversion program at the city level in China, very limited valuable experiences in waste management could be referenced by other cities. Insufficient waste data collection and research are also the big problems. Data about aggregated diversion rates and the inter-city movement of recyclables is either inaccurate or absent in Qingdao. Available resources for waste management are insufficient all over the China ([Xu 2002](#)). Resources have high opportunities costs especially in the rapidly growing region such as the city of Qingdao. The

fiscal income is the major source of waste budget. The local governments spend most of it on services and infrastructures. To change this situation and improve waste management, it requires cooperation between the government and the private sector.

4.2. Private Sectors

In Hamilton, private companies share half of the wastes treating and collecting service. In North America, private companies have demonstrated their reliability, viability and competitiveness in waste service since the end of the nineteenth century (Louis 2004). In 2000, private collectors have covered Ancaster, Glanbrook, Flamborough and Stoney Creek areas in Hamilton. These areas contain 53,200 units in the urban area, 14,750 units in the suburban area and 17,600 units in the rural area (Table 1). Usually, costs of contractors include contract costs (monthly invoice, labor, vehicle costs and administration fee), indirect cost and overheads. As calculated, the cost per property for the contractor is closed to the cost of public sector. However, contractors usually develop their own market for recycled materials and recovered stuffs because they chase profits. Contractors may export certain type of waste to more labor intensive countries for processing and disposing. Many concerns rise about the environmental impacts of reuse and recycle processes (Goodger 2011). All contractors will confront these concerns about the balance among economic benefits, environmental protection and social responsibilities.

Service Provider	Zone	Units (2009)	Special Features
Public	A1 - Hamilton, below escarpment	51,500	Urban, high-density, one way streets, on-street parking
	A2 – West Hamilton, Dundas	12,750	Suburban, medium density
	A3 – Flamborough	14,200	Rural, with future growth areas

Private	B1 – Hamilton, above escarpment	53,200	Urban, high-density, one way streets, on-street parking
	B2 – Stoney Creek	14,750	Suburban, medium density
	B3 – Ancaster, Glanbrook	17,600	Rural, with future growth areas
Contracted (Recycling/Front End Bin Collection)	Service for all zones	164,000	

Table 2. Waste collection zones in Hamilton (Vidler 2012).

In Qingdao, most of the waste services are not delivered by formal private sectors. It is the informal private sectors that play a crucial role in MSW recycling and recovery (Guo S 2000). These informal sectors take place at all levels and every stage of the waste management stream, and strongly influence the flow of the waste stream in China. At present, MSW is collected in a mixed state. The recyclable materials from MSW are collected by scavengers at the landfill sites and junk-buyers patrolling the residential areas. Residents sell recyclables they collected to junk-buyers. Sometimes, they also deliver recyclables to the recyclables distribution centre by themselves. The recyclables distribution centre is the place where buys the materials from junk-buyers and residents. Then it sorts and sells these materials to factories as raw or processed materials (Dongqing Zhang 2010). However, current informal sectors are not lasting solutions for wastes diversion. Because scavengers at landfill sites are taking high health risks from the dirty, fetid environment, and junk-buyers and residents only collect the recyclables with commercial values and throw the other less value wastes into MSW stream. On the whole, diversion through informal sectors is an ineffective way to increase the division rate and reduce the waste from the source.

5. INTERACTIONS

5.1. Intra-Governmental Integration

The intra-governmental integration refers to common objectives sharing and responsibilities refining among multiple government divisions in an ISWM system. Divisions share common objectives and take specific responsibilities in the management system. In Hamilton, the major division that administers and manages MSW within the Region is the Waste Management Division. It is under the regional municipal government. For instance, the Green Cart program was endorsed by the council without any controversy because diverting more wastes to save the landfill space seems to be a common acknowledgement among staff and councilors.

In Qingdao, the Environment and Sanitation Department is in charge of MSW management and waste services delivery. As the circular economy brought out, the Development and Reform Committee and the Environmental Protection Bureau are also involved because they manage the recycling and recovery which are under the umbrella of circular economy. However, these divisions do not have exactly the same primary objectives and concerns. The Environment and Sanitation Department is the division for waste collection and concerns more about safe disposal and cost-effectiveness rather than promoting recycling and recovery. Moreover, the communication between these departments is ineffective and lacking. Unless there are large projects such as the composting plant or incineration plant, multiple divisions will participate and vote in the processes of bidding, sighting and environmental assessments.

5.2. Public-Private Cooperation

In Hamilton, the cooperation between public sector and private sector is built on contract-based. Careful contract management is the key to make sure that citizens receive the best value and

service from private contractors. Over years, the City of Hamilton has developed waste collection contracts that clearly state requirements and expectations from private contractors. Local unions have supported the municipality having waste collection contractors which can provide some flexibilities and has less disruption on municipal service labors. So union representatives view a split model as a step to full privatization.

The City of Hamilton has developed an Activity Based Costing (ABC) model to measure costs and effectiveness between the public sector and private contractors. The ABC model identifies resources to provide waste collection service and measures costs and efforts required to operate the waste collection programs. The "direct", "indirect" and "overhead" costs for waste collection have been taken into consideration by the ABC model. Direct costs of the public sector typically include employee wages, fleet costs and benefits while the private contractors' direct costs are based on the contracted price which includes labor costs, fleet costs, administrative costs and profits. Taking indirect costs and overhead costs into consideration could make the public costs more comparable. Indirect costs include operating costs, waste collection administration, customer service, building costs, maintenance supplies and contract supervision. Overhead costs are based on a range of expenses such as solid waste planning services, senior management and finance (Table 2). To compare the outcomes, the model tracks several outputs including waste tonnage collected and number of customer service calls. These outputs are comparable for both public sector and private sector (Goodger 2011).

Costs	Public (A zones)	Private (B zones)
Direct	Operating costs to collect waste in a	Contract prices based on

Costs	particular zone (i.e. labor) Fleet costs per zone (i.e. fuel, maintenance, insurance, fleet services)	contractor's monthly invoices (includes labor, vehicle costs, contractor's administration, contractor's overhead, etc.)
Indirect Costs	Collection Administration (Management, supervision, field staff) A zones customer service Staff vacation Staff training Work Accommodation Safety equipment Office & maintenance supplies	Collection Administration (i.e. Management) City's contract supervision (i.e. Project Manager, field staff) B zones customer service
Overhead	Staff costs (Director, Solid Waste Planning, etc.) Community Outreach Note – these costs are apportioned across all zones	Staff costs (Director, Solid Waste Planning, etc.) Community Outreach Note – these costs are apportioned across all zones

Table 2. Activity based costing for both the public and private sectors (Vidler 2012).

Analysis indicates that the competitive model is an effective model to lower the public service expenditure. In 2010, the public cost is \$96.77 and the private cost is \$101.76 per eligible property. However, the previous results had shown the public cost to be higher. For instance, the public cost \$71.91 is higher than the private cost \$60.88 in 2003 (Table 3). This clearly illustrates advantages of the ABC model (City of Hamilton 2012). To ensure transparency in the costing and Request for Proposals (RFP) process, a separate internal team called "Chinese Wall" has been set up for working independently on the public sector costing. As the private contractor responses to RFP, the costing is submitted in a sealed envelope at the same time. The RFP document clearly sets out a process to state service delivery requirements, evaluation and selection processes which should be followed for both public and private sectors. The city's waste management has used data from the ABC model to identify where improvement is needed to conduct, and the results show that the public sector service is competitive. In the situation where competition, performance monitoring, and accountability exist, the desired efficiency of a

Public-Private cooperation materialize. So the City of Hamilton has realized that simple privatization is not the only way to achieve good results.

	Costs (Organics/Garbage/Yard Waste Bulk)	ALL A (Public)	ALL B (Private)	Total	Difference Between Public and Private
2007	Total Cost	\$6,845,400	\$7,832,900	\$14,678,300	
	NO. of Properties	76,407	82,662	159,069	
	Cost per Properties	\$89.59	\$94.76	\$92.28	-\$5.17
2008	Total Cost	\$7,280,100	\$8,429,000	\$15,709,100	
	NO. of Properties	77,708	82,530	160,238	
	Cost per Properties	\$93.69	\$102.13	\$98.04	-\$8.45
2009	Total Cost	\$7,417,500	\$8,219,800	\$15,637,300	
	NO. of Properties	77,844	85,221	163,065	
	Cost per Properties	\$95.29	\$96.45	95.90	-\$1.17
2010	Total Cost	\$7,135,900	\$8,702,600	\$15,838,500	
	NO. of Properties	78,450	85,550	164,000	
	Cost per Properties	\$96.77	\$101.76	\$99.38	-\$4.99
2003	Cost per Properties	\$71.91	\$60.99	\$66.17	\$11.03

Table 3. Financial Results of the public and private sectors in Hamilton (Vidler 2012).

In Qingdao, existing public private cooperation does not spread as widely as Hamilton does. The cooperation is all based on a Build Operate Transfer (BOT) contract. As illustrated in BOT, private contractors are franchised to build a government-driven project and operate for a certain time before transferring it back to the State. The local governments are clearly not relying on the private contractor in waste services. They are just taking advantage of private contractors to finance, manage and market the component that is lack of resources and expertise. Such public-private partnerships are only used in large projects such as composting plants and incineration projects and have not been firmly allowed in collection, separation, recycling and recovery areas. Moreover, most of funding for waste management in Qingdao has been provided by city revenue

and central government subsidies. Less than 15% of service costs is paid by households whose waste is collected by door-to-door ([Wenxia Xie 2012](#)). Limited financial resources and the absence of incentives to encourage high performance productivity have been indicated as a major problem that undermines the waste management system. The involvement of the private sector to provide waste recovery, composition and even incineration service could help fund some parts of the MSW management system by generating revenue.

A lesson can be drawn from the City of Hamilton to provide a clear pathway and stability for increasing performance efficiency and enhancing environmental protection is the introducing the Public-Private cooperation to MSW management system in Qingdao. Considering that the local government of Qingdao lacks financial resources as well as a qualified and motivated human resource base, Public-Private cooperation results in the low service costs and the environmentally effective system. The greatest opportunity to involve the private sector relies on having companies provide collection services under a contract with the local government. ABC model exhibits a feasible option for the local government to wide ownership, prevent its concentration and encourage competition. However, it would be desirable for policy-makers and experts to evaluate the environmental impacts from the private firms, develop performance indicators, establish monitoring plans, and conduct a cost-benefit analysis to define the most effective and least expensive option. There are unusual factors such as collusion, cartels, hidden subsidies, unsafe labor practices, unnecessary costs and excessive costs in developing countries ([EL-FADEL 2002](#)). To avoid these possible factors, a progress like the RFP to ensure complete transparency particularly with regards to financial accountability should be built. In the Public-Private cooperation, competitive tendering and complete transparency are essential elements.

5.3. Public Participation Promotion and Public Education

Waste management system in Hamilton is developed based on the support of residents. Proposed strategies for waste management are subject to residents' opinions which is stated in the Waste Management and Minimization Plan 2012. From the fundamental principal of the plan, residents' opinions are utilized in improving and implementing waste management plans for the city ([Hamilton City Council 2012](#)). To ensure that residents and communities hold themselves accountable to waste management system and make the system sustainable, residents are at the centre of waste management in Hamilton. The City of Hamilton has conducted a series of activities including holding open-houses and delivering newsletters, door hangers and other materials to promote public participation.

In Qingdao, most residents have to perform a very low level of separation at home due to the absence of the formal waste separation programs. However, the low level of separation at home is mainly because of lack of proper public education. Public education for waste diversion in Qingdao mostly focus on concepts instead of specific instruction. For example, multiple level governments only propagate that MSW should be separated for recycling and protecting the natural environment.

6. DISCUSSIONS AND RECOMMENDATIONS

Summarizing the MSW management systems in Hamilton and Qingdao, we can see that the MSW management system in Hamilton has a higher degree of integration and a higher diversion rate than that in Qingdao. Besides, the City of Hamilton has built much sounder relationship with private contractors through the unique competitive spilt model. Table 4 summarizes Hamilton and Qingdao's waste separation programs, treatment methods, management tools, interaction among government divisions, public-private cooperation and education. There are external and internal factors contributing to the differences between these two cities. For the external factors which are beyond the control of the waste management system, Qingdao has a relatively higher population density which needs the different services manner. For instance, the Blue Box or the Green Cart for each household and collection on a weekly basis will not satisfy the needs of residents for waste service in Qingdao. Setting up neighborhoods sharing collection stations and delivering more frequent collection services are more practice. Moreover, although Qingdao has a rapid growing economy, the social welfare per capita is relatively low compared with its economic growth. That determines Qingdao has quite high opportunity costs of resources and low capacity. So it is impossible for the local government to promote recycling regardless of costs. Cost-effective and reliable private sectors become more vital than any ever before for a robust public-private cooperation. Besides, the recycling and recovery in waste services are carried out by informal sectors for quite a long time, and it greatly contributes to the large number of immigrants and the larger gap of incomes and education levels between the rich and the poor. These conditions will continue to be the obstacle for the integration for a period of time and go far beyond what waste managers can improve.

	Performance	
	Hamilton	Qingdao
Separation Programs	Around 49% diversion rate; diverse programs operated by the	No official data on diversion rate; no official diversion programs yet;

	municipality and private contractors	separation done voluntarily by residents and informal sectors.
Treatment Methods	The major disposal methods remained landfill; recycling of Blue Box wastes; centralized and normal composting.	Landfill is the dominant method; recycling and recovery of wastes collected by informal sectors.
Management Tools	Waste Division Act; waste management master plan; financial tools (e.g. subsidies to the Green Carts)	Policies on promoting waste reduction and recycling; no waste management master plan; recyclable wastes sold for business.
Government Interactions	Common understanding on waste division within the government.	Slightly different concerns within multiple government levels
Public-private Cooperation	a split waste collection model; the City of Hamilton expanding its competitive model to recycling collection.	The informal sector not under effective administration; private companies just started cooperation with government.
Education	Education activities with specific instructions and information packages.	Education programs lacking specific instructions.

Table 4. Summary of MSW management systems in Hamilton and Qingdao.

Refer to the internal factors, it is mainly about the interaction among components and their interests. In Qingdao, the local government regards the safe disposal as its first concerns when it deals with promoting waste recycling. It strictly treats the waste service as a type of public service while private contractors consider it as a business opportunity. As informal sectors, the local scavengers and junk-buyers are not in collaboration nor administered by any authorities, but they do contribute significantly to the current recycling system in China. At the same time, they are still taking the health risk from unsanitary landfill sites and disordered recycling market (sometimes junk-buyers are exposed to dangerous chemicals, but they do not know). These concerns should be carefully mediated if Qingdao may initiate new recycling programs.

Understanding these external and internal factors, the local government of Qingdao could better understand the mechanism of an ISWM system in Hamilton and apply useful experience in future planning. First, making a master plan could initiate sounder interactions. In developing the plan, except taking into account the basic information (e.g. the waste generation source, quantity, characteristics and socio-economic structure of the city), all possible stakeholders in the waste management system should be identified and involved in the planning process at early stages. Making a master plan could follow these steps: review current MSW management system, identify key problems, generate performance indicators, set up objectives, and specify duties and roles of relevant government divisions. Besides, the performance indicators and objectives should be agreed upon by all stakeholders. Proper communication to all parties should be encouraged so as to increase information transparency. Planners should design a proper process and establish a common objective to promote effective communication, competition and cooperation based on understanding the needs and concerns of different sectors and fully considering their respective social and economic status. With this master plan, it could greatly improve cooperation among different government divisions and within public-private sectors.

Second, legislate an incremental path, beginning with limited types of wastes and gradually expanding the scope, for the conduction of diversion programs and waste services providers to follow. In Hamilton, waste division started with few types of Blue Box wastes like paper and bottles, gradually expanded to divert more items such as electronic wastes, tires, backyard wastes and recently organic wastes. As currently kitchen wastes treatment facility building in the process, this pilot diversion program in Qingdao was advised to separate a variety of organic wastes which are costly to divert in before. The kitchen wastes treatment facility has set up a

good example for Qingdao to separate limited types of wastes in as much volume as possible rather than many types in small volumes. Because recycling has economies of scale but diseconomy of scope (RC 2002).

Third, any new diversion programs should be planned based on the already existing system. As demonstrated in the Green Cart program in Hamilton, adopting new programs with sharing existing infrastructures in MSW management system and reducing the demand for public behavioral changes will be helpful for promoting new programs. Under current circumstance of waste services in Qingdao, the local government should promote the formal waste division program without exiling informal sectors and should cooperate with them. As informal waste division activities are profit-driven, better cooperation with the informal agents should rely more on market-related and economic tools to support and to share benefits with them rather than just charging them with administration expenses to be formalized. In addition, cases in Asia and Latin America have shown that such cooperation could be benefits from assistances of non-governmental organizations (NGOs) or other civil society organizations (M 2000). NGOs and other organizations in civil society have played an important role in establishing cooperatives with governments, offering infrastructure and finances, providing technical supports, educational chances, health care and legal services to informal sectors (S 2006).

Fourth, the using of spilt model could smooth the interaction within different sectors. From the study of Hamilton's split waste collection model, we could find several advantages. A primary benefit is the competitive atmosphere between service providers yet disturb the public sector in

the smallest degree. The model could reduce the complacency and push the public sector to behave in a manner similar to private companies. The split model also allows the municipality to maintain control of service delivery without large capital investing to build and maintain a city-wide waste collection fleet. Knowing that the municipality is in the same business in turn stimulates private contractors to provide better pricing (Goodger 2011). This cost-effective and efficiency model is particularly helpful for Qingdao to develop pilot programs to shape the city's waste collection system. The public sector maintains a substantial presence in the service delivery to keep the private contractor honest. The direct supervision of collection activities could be reduced, and the saved staff time could be focused on contract administration. Moreover, being in the same business allows the local government to have the expertise as the private sector and make full use of the limited resource. As the trend of constructing integrated MSW management system, the split model is a stable and safe transition for Qingdao.

Fifth, the local government of Qingdao should research concerning waste management and consider more proactive investigations as the integrated system develops. Because waste services could be provided by private companies, the government should seek its new roles in waste system and make more efforts on researching like better data collection and socially acceptable strategies. A more reliable and comprehensive database is critical to understand the waste management system's status quo, support better decision making and facilitate waste planning. Citizen's views and good communication with communities could help the government better implement waste management plans, get valuable feedbacks and make sure the system sustainable.

7. CONCLUSION

In China, a more integrated waste management approach is essential to the improvement of overall efficiency so as to satisfy the need of rapid circular economy implementation. No single agent alone could solve all the problems due to the complexity of MSW management systems. From its generation, collection, to treatment and final disposal, a more integrated waste management system needs cooperation among all stakeholders including governments, private sectors and residents and such cooperation should be reflected in all stages of the MSW management process. Experiences and lessons learned from developed countries are useful guideline for developing countries' waste management designing but should not be treated as a panacea. Moreover, when we transfer successful models, we should design the whole process regarding to the local realities and selectively absorb the useful components. This inquiry paper followed such steps by applying the system approach in a comparison study in order to identify the key differences between two systems. After that, the paper explored more on the factors which contribute to these differences and found more practical strategies and useful management tools to be applied. These experiences and lessons we learned are very applicable to Qingdao, because the results are all based on specific cases. To other cities, they may not be as applicable as to Qingdao. Even for one case, lessons drawn could be greatly different from different cities. The system approach for comparative study cannot evaluate and optimize the solution by itself. However, the goal might achieve by integrating with many other decision-making strategies and empirical studies.

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