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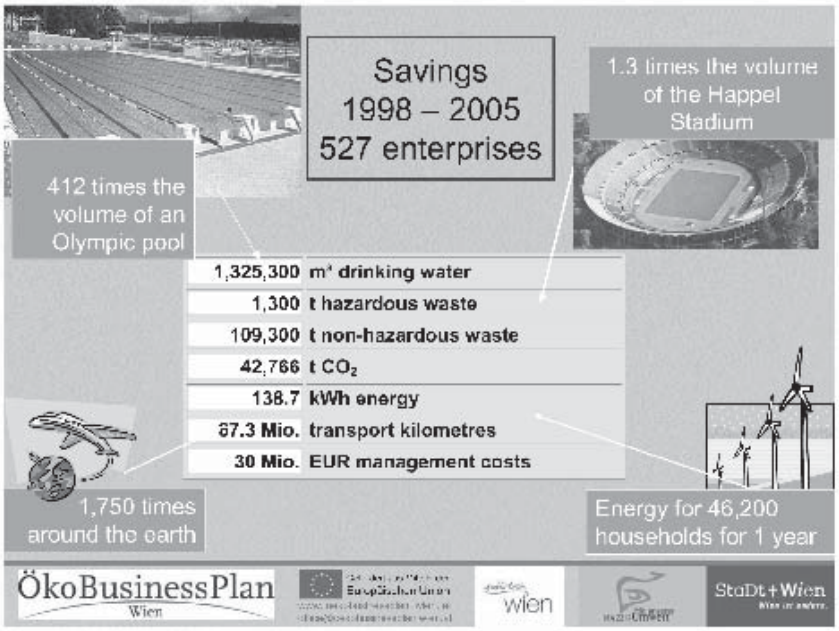
Waste Prevention in Vienna

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Abstract
In 2001 a Strategic Environmental Assessment (SEA) identified waste prevention as one of the main goals of the Vienna Waste Management Plan. As a result the programme "Waste Prevention in Vienna" was started to intensify the efforts of qualitative and quantitative waste prevention. Generally, a city administration has several instruments at hand to reach its goals: legislation, supporting voluntary measures in companies, communicating best practice examples, and carrying out comprehensive programmes in the city administration as such. Vienna has implemented waste prevention in all these fields.

1 Waste Prevention in the City Administration
Two programmes have been implemented by the city administration capable of producing a positive effect on the amounts and quality of waste. The economic budget of the city of Vienna amounts to approx. 5 billion Euro. How the money is spent has an enormous impact on the environment. Vienna has introduced green public procurement with the "Eco Buy" programme through the definition of ecological criteria to be applied as an obligatory measure. Green public procurement of cleaning products, for example, reduces costs by 10% and volume by 23%. PUMA, the second programme, implements an environmental management system in the whole city administration: better waste management with clear responsibilities, including measures for waste prevention, the reducing of environmental impacts and saving of resources. Both programmes contribute to the Klip Climate Protection Programme.

2 Voluntary Measures in Companies
The EcoBusinessPlan Vienna is a voluntary instrument for enterprises and industries aimed at improving the environmental situation through better performance. Further advantages are represented by lower operating costs, competitive



advantages for participating companies and a better relationship between companies and authorities. After a weak-point analysis companies decide to carry out certain measures. With the help of external consultants several thousand measures have been planned and realised over the past few years. Considerable amounts of hazardous and non-hazardous waste and millions of Euro have been saved (see Figure 1).

Fig. 1: Waste prevention and other savings for enterprises participating in the Eco-BusinessPlan Vienna

3 Initiative "Waste Prevention in Vienna"

The aim of the initiative "Waste Prevention in Vienna" is to initiate innovative projects, to group together waste prevention measures and to ensure cooperation with other environmental projects of the city. The projects include demonstration projects, research studies and awareness projects. Two competitions were organised resulting in the yielding of numerous projects with particularly innovative ideas. Subsequently, projects were focused on food and food packaging as well as on environmental considerations for event organisation. In 2007 efforts will concentrate further on construction waste. The programme is supported by the Executive City Councillor for the Environment and will be continued.

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An Assessment of Variable Charging Scheme as a Means to Waste Minimization

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Abstract
As a scheme for achieving the minimisation of household waste, variable (weight / volume based) charging is often suggested. It has been reported that reductions in waste arisings were observed, however it is not clear where the reduction happened (or who reduced), and what side-effects are taking place in lieu of the observed decrease in waste.

In many cases, private companies as well as the municipality collect business waste together with household waste. It could be that the waste reduction was recorded on the municipal waste statistics due to a shift in service providers. It is also important to know to which type of residents (income levels / housing types etc) this scheme is most effective (or otherwise). Another important aspect is to what extent a "genuine" minimisation has happened, and how much is it due to diversion to recycling. Recycling and minimisation should be grasped as separate concepts.

The efficacy of waste policy is often assessed by analysing the municipal waste statistics. Using the city as a unit for analysis, it is difficult to address the issues mentioned above, as arisings from areas with different socio-economic characteristics are all aggregated into one figure.

Waste arisings data including separate collections for recyclables, were made available at the school district level in Fukuoka, Japan. This splits the city (pop 1.4M) into more than 140 districts of a similar size. Using this data, it is possible to cross-analyse waste reduction with area-specific variables, before and after the implementation of the variable charging scheme.

1 Introduction
1.1 Variable Charging Schemes
As a scheme for achieving the minimisation of household waste, variable charging (VC) is often suggested. VC aims to give a financial incentive for households to reduce waste by charging a variable fee according to the volume or weight of the waste each household generate, whereas conventionally, households pay a fixed

sum for the collection and disposal of their waste, either through tax or a separate charge. Although there have been criticisms to the idea of VC[1], it is sanctioned by the Ministry of Environment, and several municipalities in Japan have implemented volume-based designated bag schemes. Waste is collected only when it is put out in these bags, and the prices of these bags include a part of collection and disposal costs (rest of the costs is financed by tax). The reported results are varied, ranging from no reduction to almost 50% reduction (Yamakawa and Ueta 2001). In addition, it is not clear what the main direct cause of the change in arisings is[2], and what side effects are taking place in lieu of the observed decrease in waste. There are doubts that "shifts"[3] of waste has happened to some extent, instead of a "genuine" waste reduction. It is desired that these points are made clear.

It is also important to know who - what type of residents (income levels / housing types etc) or small businesses - contributed most to the reduction. Then we will know to whom this scheme is most effective (or not).

Shift of service providers:

In many cases, municipalities collect business waste together with household waste as "Municipal Solid Waste". At the same time, private companies also provide waste collection service to businesses. It is natural to assume that if the price of service provided by one sector (municipality) rises, there will be a shift of demand to the other sector (private). As a result, a decrease on waste arisings will be recorded on the municipal waste statistics, and the distinction between household and commercial arisings is vague. It is often difficult to deny that the waste reduction was due to shifting of service providers.[4]

Shift of waste to "recyclables":

It has been long since the "waste hierarchy" has been advocated. In this hierarchy, reduce is prioritised before recycling. The topic of the session in which this paper is submitted to, is "assessment of waste minimisation". In this context, I consider "waste minimisation" synonymous to "waste reduction", although I

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1 Main criticisms are; that it is a de-facto increase in tax, that it is socially regressive - more pain for poorer households and not much of a signal for the richer, fear of increased fly-tipping, administrative cost being large compared to its benefits, that it can cause conflict with good will - it inhibits, for example, voluntary litter picking activities in public spaces, and that it shifts the burden of the waste problem to consumers while producers should have assumed more responsibility.

2 It has also been pointed out that other changes in the collection system are often introduced at the same time as VC (e.g. changes in separation categories and collection frequencies), and that it is difficult to determine what was the main cause of changes in waste arisings.

3 Two types of "shifts" are mentioned in the boxes above. There is a third type of shift, which is a shift from proper collection/ disposal to fly-tipping. This is a much feared side effect of variable charging, and that has actually happened in many cases (Miranda et al., 1994, Fullerton and Kinnaman, 1996, both cited in Yamakawa and Ueta, 2001).

4 There have been reports that up to 50 % of the reduction is due to "shifts". (Tanaka et al. 1996, cited in Yamakawa and Ueta, 2001).

acknowledge there is some difference in connotation. Regarding the hierarchy, reduction of the amount of waste directed to disposal by recycling should not be considered as "waste reduction". It is important to examine to what extent a "genuine" minimisation has happened, and how much is it due to shifting to recycling.

1.2 Analysis of Waste Statistics

The efficacy of waste policy is often assessed by analysing the municipal waste statistics (e.g. Sasao, 2000, Yamakawa and Ueta, 2002). A typical approach is carrying out a multiple regression analysis on per capita waste arisings of municipalities with independent variables including policy factors as well as other demographic and socio-economic factors. In this way, municipalities with or without a certain policy can be "controlled" for other variables and the effect of the policies can be assessed.

Yamakawa and Ueta's (2002) results indicate that neither household size, percentage of detached housing, nor the number of small businesses (1-4 employees) per population have any significant influence on waste reduction through VC. However, using the municipality as a unit for analysis, it is difficult to assess the differences in these factors. A city comprises of areas with various socio-economic characteristics, with varying concentration of businesses and residents. If there is only one figure each on waste arisings and the corresponding factors for the whole area, it is very difficult to tangle out the effect of each factor.

It is not only the averaging out which is the problem. Municipalities come in various sizes[5], and often a heteroskedasticity problem arises. This is a problem where the variance of the dependent variable is not uniform across the x-axis. Smaller-sized municipalities tend to have a larger variance in most social statistics. Weighted Least Squares method is suggested as a remedy for heteroskedasticity, but it has been indicated that with waste data, the choice of the weight variable, which is to some extent discretionary, is very sensitive to the results. For example, as Table 1 shows, the coefficients for [income] turns out to be either positive, negative, or insignificant, depending on the choice of the weight variable (Watanabe 2003).

The above suggests that data based on even-sized units at a level smaller than municipalities would be effective for analysing the relationships between waste arisings and socio-economic characteristics of the area.

2 School district analysis (Fukuoka-city)

In most municipalities, waste arisings data broken down into sub-areas of the city is not available[6]. However, waste arisings data at the school district level were

5 In Japan, the size of municipalities varies from Tokyo (population; 8 million) to Aogashima (an island off the pacific coast – pop. 200). In England the variance in size is smaller, yet the difference is still larger than 10-fold.

6 As the unit of operation is the city, it is relatively easy to keep an account of the total

Tab. 1: Analysis of total waste arisings of municipalities in Japan, 2003 (n=3133)

Weight	OLS		WLSrawP		WLSlogP		WLSsqrP	
	beta	t	beta	t	beta	t	beta	t
LogPop	0.189	8.090	0.336	11.219	0.191	7.977	0.233	8.825
PopDen	-0.100	-4.526	-0.165	-6.800	-0.107	-4.778	-0.133	-6.105
Income	0.111	4.731	-0.222	-9.240	0.100	4.178	-	-
InvP/hh	0.164	8.676	0.207	8.325	0.158	8.377	0.160	7.914
1ind%	-0.141	-6.400	-0.262	-12.668	-0.151	-6.752	-0.209	-9.710
Popdiff	-0.041	-2.093	-	-	-0.044	-2.230	-0.040	-2.183
day/night	0.132	7.193	0.164	11.441	0.135	7.373	0.145	7.991
Adj R^2	0.159		0.375		0.167		0.209	

Stepwise Multiple regression - Criteria based on probability of F, <=.050 to enter, >=.100 to remove
Standardised coefficients (beta), Student's t, and Adjusted R squared
Independent variables: Log of population, Population density, Taxed income per person, Inverse of person per houshold, Population difference (1995-2000), Daytime population ratio
Weight variables: raw value of population, log of population, and square root of population

made available in Fukuoka, Japan (Fukuoka-city 2006). Fukuoka is the largest city on Kyushu Island with a population of 1.4 Million. As of 2006, there are 144 school districts in the city, each with about a population of 10 thousand[7].
Initially, this was possible because each collection vehicle had its collection round trips clearly defined and fixed, and weighbridge measurement was made for each vehicle for each trip (Yanase et al., 1996). Recently, the vehicles are equipped with GPS and photoelectric sensors, with which data with much more accuracy is generated (Suzuki et al., 2004).

In Fukuoka, waste from households is collected separately in 3 fractions, namely "burnable", "non-burnable", and "glass and plastic bottles". The last fraction is aimed for recycling, whereas recyclable metallic items are included in the "non-burnable" collection, and subsequently mechanically sorted for recycling. "Burnable" is collected twice per week, "non-burnable" and "bottles" once a month. The system with GPS is in use for these three fractions to generate school district data. Commercial waste is collected by private contractors, and business premises are not allowed to put out their waste for the household collections.

The city subsidises 1700 organisations (neighbourhood associations, boy scouts etc.) carrying out voluntary recycling schemes. The major item recycled by these schemes is wastepaper. Residents can also bring wastepaper to "recycling

amount of waste being dealt with. However it is prohibitively difficult to track down the day-to-day activity of each waste collection vehicle, and aggregate the tonnage according to sub-areas.

7 There are six districts with population less than 1000. These are few small islands included within the city boundary.

boxes" at 350 locations around the city. Arisings data at school district level is available for these as well (hereafter referred to as "wastepaper"). In addition, the city operates nine "bring-in" recycling centres, and there are wastepaper collection organised by private companies, but tonnages from these are not included in the school district figures.

In October 2005, Fukuoka city introduced VC based on a designated bag scheme. The bags are either 30 or 45 litre (15 litre bag is also available for "burnable"), and they are priced at JPY1/litre for "burnable" and "non-burnable". The price of the bags for "bottles" is set at JPY0.5/litre to encourage thorough separation of this item which is recyclable.

The waste arisings data used for analysis below are for the period between April and July in the year 2005 and 2006. This is to avoid the data being influenced by probable last minute "disposal rush" before the introduction of VC[8]. Independent variables used in the analyses below are from national census and other public surveys. Figures of each census enumeration districts are aggregated to match the school districts.

2.1 Analysis of arisings

Before looking into the effect of VC, we shall look into the factors influencing current waste arisings. Analyses at school districts level are unique in the sense that system/policy factors are eliminated. When inter-municipal data is used, each municipality differs in its system and policy (categories for separation, collection frequency, extent of advocacy on waste minimisation, etc.). Here we can see that waste arisings vary considerably within the city. The average arisings and their range for various fraction of waste are shown in Table 2. Choropleth maps of arisings as well as independent variables were created (e.g. Figures 1 - 4).

Tab. 2: Average and range of arisings, Pre and Post VC differences [g/person/day]

	05 Avr	05 Min	05 Max	06 Avr	06 Min	06 Max	Diff Avr	Diff Mx	Diff Mn
burnable	645	500	820	583	356	716	-62	-264	+38
non-burnabl	52	31	85	34	25	54	-18	-41	-3
bottles	17	9	28	16	7	27	-1	-7	+4
wastepaper	79	23	143	(115)	n/a	n/a	(+36)	n/a	n/a
Total	793	674	951	(748)	n/a	n/a	(-45)	n/a	n/a

In existing studies based on municipal data (i.e., city as an unit), it has been almost unanimously indicated that the amount of waste per capita has a correlation with the inverse of the number of person per household (invP/HH); i.e., smaller households generate more waste per person (Jenkins, 1993, Sasao, 2000, Yamakawa and Ueta, 2002 etc). The hypothesis supporting this correlation is that there are many

8 Looking at Jul-Sept 2005 data, an increase especially in "non-burnable" was observed.

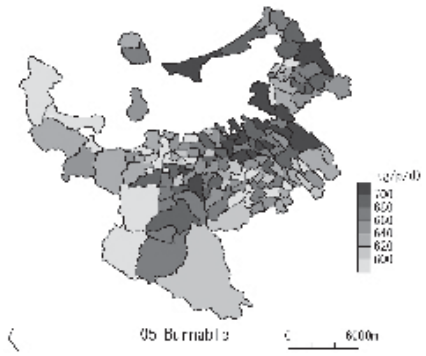


Fig. 1

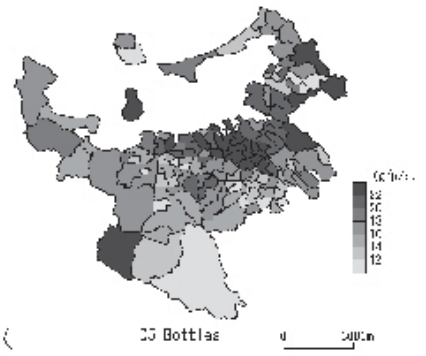


Fig. 2

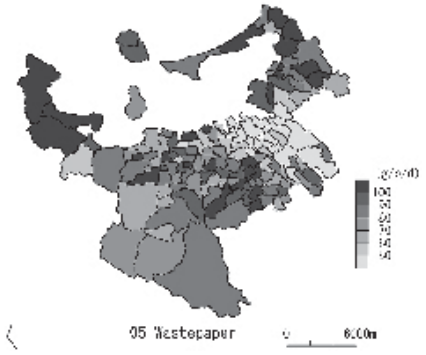


Fig. 3

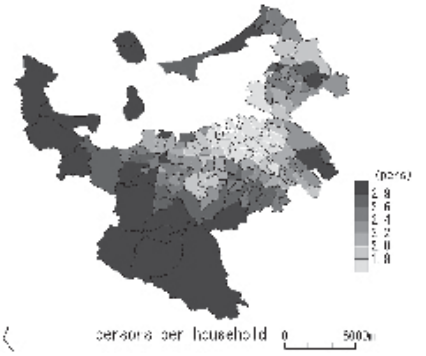


Fig. 4

items that are consumed per household (e.g. newspaper subscription), and also larger households tend to purchase food and other consumables in larger units, hence less packaging per content. Here as well we shall look into the relationship between household size and waste.

As indicated in Figures 5-9, "burnable" and "bottles" have a relatively strong positive correlation between invP/HH. However, for "non-burnable" there is almost no correlation, and for "wastepaper" there is a negative correlation. It seems plausible to assume that larger households (often with schoolchildren) co-operate more to wastepaper collection accounted in the statistics here. Most of the schemes grasped by the city are run either by neighbourhood associations or

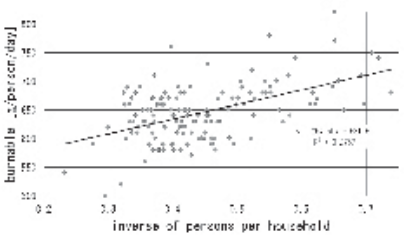


Fig. 5

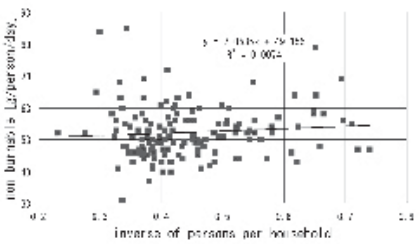


Fig. 6

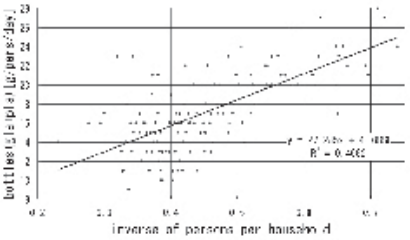


Fig. 7

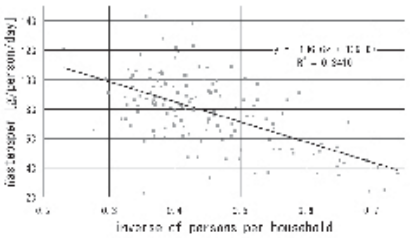


Fig. 8

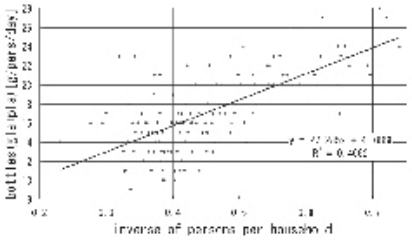


Fig. 9

school-related groups. Single-person households are less likely to be members of these organisations[9]. Recycling boxes installed by the municipality are often located adjacent to school premises and are only open 9-17 hrs on weekdays. For "total waste" there is a positive correlation between invP/HH as in the city-unit analyses, but the correlation coefficient (r-squared) is low. The figures shown below are for the year 2005, but the 2006 data also showed similar tendencies.

Correlation analyses with other local socio-economic variables such as 1) housing size per person (in square meters), 2) percentage of detached housing, 3) business premises per population (as a surrogate for the possibility of commercial waste being collected as household waste), 4) house ownership rate, and 5) unemploy-

9 One does not need to be a member to use their recycling scheme, but non-members may not be aware of the existence of such schemes.

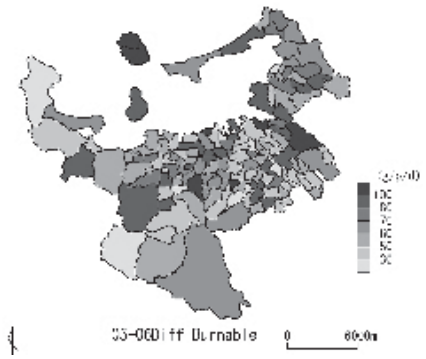


Fig. 10

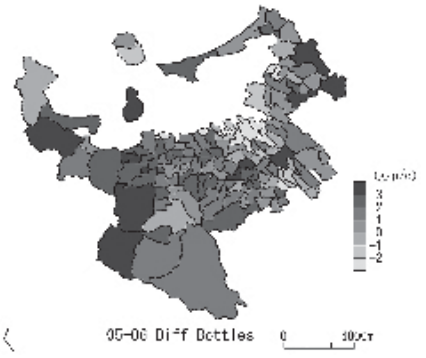


Fig. 11

ment rate were carried out, but they did not show any strong correlation with total waste arisings in both single and multiple correlation analyses (r-values in single correlation were 0.22, 0.08, -0.01, -0.00, and -0.02, respectively). Looking at individual fractions, house ownership rate and "+5yrs at the same address" rate had positive correlations with "wastepaper" (r=0.47, 0.41), which agrees with the characteristics of this collection, as mentioned above.

2.2 Analysis of pre/post Variable Charging

The average and the range of differences in arisings between 2005 (pre-VC) and 2006 (post-VC) are shown in Table 2 above. The school district data for "wastepaper" in 2006 is not yet available. It has been reported that there was a 46% increase in tonnage for the recycling boxes[10]. Decrease was marked in "non burnable" (ca. -30%), while "burnable" decreased about 10% on average. On the other hand, there was almost no difference in the average arisings of "bottles". Figures 10 and 11 shows examples of the spatial distribution of these differences.

Assuming that "wastepaper" in total increased by 46%, there is an overall decrease of about 6%, but it is not conclusive whether a genuine waste reduction had occurred with VC, as recycling carried out totally by private sector is not included in the figures. Also there is a possibility of commercial waste being more thoroughly segregated from household waste with the introduction of VC[11]. When household waste was collected for free, there was a larger incentive to (illegally) deposit commercial waste as household waste. The mixture of commercial waste into household waste is pointed out as an important factor influencing household

10 Also there was a 21.6% increase in collection at recycling centres (4.2 g/person increasing to 5.1)

11 However, the correlations between the differences and the number of business premises per population were low. Adding the fact that there was little connection between household waste arisings and the number of business premises, it may be that household - business segregation had already been relatively strict pre-VC in Fukuoka.

waste arisings (Edwards et al., 1993, Matsuto and Tanaka, 1993).

There is a sizable variance in pre- and post-VC differences among school districts. Regarding the "burnable" fraction, there appears to be some outliers. Eliminating those, the range is between 24 and 109g/ person/ day. For other fractions, the values are more or less clustered.

Regression analyses were conducted between the differences in each fraction and socio-economic variables. However, there was no marked correlation, except that districts that had a higher arisings in "burnable" and "non-burnable" tend to have a higher decrease in the respective fractions.

3 Conclusion

It appears that the introduction of VC has encouraged residents to segregate recyclables more rigorously than before. However, when it comes to genuine minimisation, it is not certain. This should become clearer when the 2006 data on "waste-paper" becomes available, and also with a careful estimation on the tonnages for private sector recycling. It is probable that reduction in the non-recyclable fraction be offset with the increase in non- (or less) charged recyclable fraction.

As long as the policy is not directed to the supply side, consumers do not have much choice when purchasing daily necessities. Whether or not under VC, the same amount of items become unnecessary in the households, and it is a matter of whether disposing it as mixed waste, or as separated recyclables. Upstream policies such as banning, restricting or taxing single-use containers would probably be more effective in minimising the overall arisings.

It was shown here that there is a large variance in the effect of VC among school districts. However, we are not yet able to identify what the influential factors for the differences are. Identifying the factors and establishing a numerical model on the effect of VC remains to be an important task to worked on, as this will provide important clues on assessing how and under what conditions VC is effective.

References

Edwards, P.; Leach, B. and Whittaker, L. (1993) "An overview of the methods used by local authorities to collect waste statistics" Department of the Environment research contract PECD 7/10/265 MEL Research

Fukuoka-City (2006) Chiiki goto no Gomi to Risaikuru ryo (Amount of Waste and Recyclables according to District) <http://www.fch.chuo.fukuoka.jp/gomi/gps/HTML/top.htm>

Fullerton, D. and Kinnaman, T.C. (1996) "Household responses to pricing garbage by the bag" The American Economic Review 86: 971-984

Jenkins, R. (1993) The economics of solid waste reduction: the impact of user fees, Edward Edgar

Matsuto, T. and Tanaka N. (1993) "Study on the nationwide waste statistics in Japan for integrated solid waste management" Journal of the Japan Society of Waste Management Experts 4(1): 10-18 (in Japanese, with English abstract)

Miranda, M.L.; Everett, J.W.; Blume, D. and Roy, B.A.Jr. (1994) "Market-based incentives and residential municipal solid waste" Journal of Policy Analysis and Management 13: 681-694

Sasao, T. (2000) "An analysis Considering the Regional Factors of the Effects of User Fees and Sorted Collection for Solid Waste Services on the Reduction of Waste" Waste Management Research 11: 1-10 (in Japanese, with English abstract)

Suzuki, S.; Matsufuji, Y.; Saito, M. and Kamo, K. (2004) "Monitoring of waste arisings by GPS and GIS" Proceedings, Japan Socieity of Waste Management Experts 15: 335-337 (in Japanese)

Tanaka, N.; Yoshida, H. and Kameda, M. (1996) "The effect of variable charging on municipal solid waste, toward less resource consuming lifestyle for households" Heisei 7 nendo kagaku kenkyuhi hojyokin kenkyu seika houkokusho (in Japanese)

Watanabe, K. (2003) "The Management and Recycling of Household Waste in England and Japan - a comparative study" PhD dissertation submitted to the University of Cambridge

Yamakawa, H. and Ueta, K. (2001) "Overview and Future Subjects of Studies on Variable Rates: Literature Review" Waste Management Research 12: 245-258 (in Japanese, with English abstract)

Yamakawa, H. and Ueta, K. (2002) "Waste reduction through variable charging programs: its sustainability and contrbuting factors" Journal of Material Cycles and Waste Management 4: 77-86