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Household Waste Management in Mashad: Characteristics and Factors Influencing on Demand for Collecting Services

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Abstract: In order to characterize household waste management system in Mashad (Northeast of Iran) and evaluate factors which affect on demand for waste collecting services, a field survey was conducted. One hundred ninty eight families were selected according to classified randomized sampling system and data on their socio-economic characters including home area, type (apartment versus other types) and tenure (private versus rental), education, separating solid and organic wastes, family size and income were gathered using questionnaires and direct interview. Results showed that three variables including staying at home during day, home type and family size explained 21% of variations of demand for waste collecting services. The study emphasized on components of pricing and economic motivations as well as education and socio-economic factors for decreasing of household waste production. Suggestions have been presented for improving the efficiency of waste management system in Mashad.

Key words: Household waste, collecting service, Mashad, socio-economic factors

INTRODUCTION

Waste production has increased substantially by developing urbanization and population explosion during last decades (Suocheng *et al*., 2001). Global MSW production in 1997 was 0.49 billion tons, with production of MSW growing at 3.2-4.5% each year in developed countries and at 2–3% per annum in developing countries. Based on these data, the problem of MSW management has earned increasing attention as a major hindrance to urbanization and economic development all over the world. In Mashad, as second metropolitan in Iran, 1300 ton wastes are collecting daily by 3000 municipality workers in which 68% is wet and 32% is solid wastes. Economic value of Mashad solid wastes is estimated annually 70,000,000 USD (Ghorbani, 2003). Per capita waste production in Mashad is 500-700 g day^{-1} plastic, paper, metal, glass and organic wastes are 20, 140, 40, 30 and 700 ton day^{-1}, respectively (Papoli, 2001). Because of waste production increase, costs of collecting and landfilling, municipality economic limitations, land scarcity for landfilling as well as ecological costs of hazardous wastes and environmental concerns, an organized waste management system in Mashad is a necessity. In many metropolitans of developing countries, government and local authorities are responsible for management of MSW system from start point of collecting to final processing, but most organizations fail to provide the service well due to several reasons (Kassim and Ali, 2006). It should be noted that any failure in waste production and collecting in future will result in irreversible environmental impacts (Mor *et al*., 2006). Now, waste management system in Mashad relies mainly on minimizing waste production. Three main parts of this system is reducing waste production, reuse of some wastes and finally, recycling of them. To do this, three strategies can be applies which are education, pricing on collecting services and controlling the waste production (Ghorbani, 2003). The important key is that a single policy can not work properly and policy makers should apply an integrated policy system to improve the efficiency of waste management system.

Studies show that several socio-economic factors including age level and distribution, family income and size, education, commodity price, price of recycled materials, home tenure (private versus rental) and area, race, climatic condition, waste collecting frequency as well as composting are crucial in waste production and therefore, demand for waste collecting services (Jenkins, 1993; Hong *et al*., 1993; Miranda *et al*., 1994; Morris and Holthausen, 1994; Sterner and Baitelings, 1999). The objectives of this study are to identify different aspects of waste production and demand for collecting wastes in Mashad and to clarify some strategies for improvement of household waste collecting system.

MATERIALS AND METHODS

In order to collecting required information, a field study was conducted in Mashad, Northeast part of Iran during 2004-2005. Mashad is the second city of Iran

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and has a population of 3,000,000. As the city is a religious city, it has 15,000,000 tourists per year. The survey method was applied for study and a questionnaire was designed. Four approaches was considered in the questionnaire which are people point of view and behavior related to waste and its recycling, their tendency to pay the costs of collecting services and urban policies and management strategies. The questionnaires were filled by direct interview with householders.

Samples were selected according to classified randomized sampling system; so, different classes of families with respect to socio-economic factors, especially economic ability had been covered. Questionnaires passed the validity tests and 198 families were interviewed.

Linear regression model was applied to evaluate factors influencing demand for waste collecting system. The model equation is:

$$D_{waste} = \alpha + \Sigma \beta_i X_i + \Sigma \gamma_j D_j + U$$

in which D_{waste} is demand for waste collecting services that measures based on per family waste production; X_1 is the number of family members which stay in home during the day, X_2 is family size (person), X_3 is home area (m^2), X_4 is family income per month, X_5 is home garden area (m^2), D_1 is virtual variable of home type (apartment = 1, others = 0); D_2 is virtual variable of doing waste separation (yes = 1, no = 0); α , β_i (I = 1, 2, 3, 4 and 5) and γ_j (j = 1 and 2) are regression equation parameters which should be estimated and U is stochastic residual term.

RESULTS AND DISCUSSION

Sample characteristics

Home and home garden area: Home area is an important factor that affects directly the waste recycling and composting, because the bigger homes usually have bigger gardens which facilitate composting the wastes. In other hand, bigger homes usually produce more wastes.

The mean home area and home garden area in the study was 140.55 and 2.62 m^2, respectively. 20.7% of homes have gardens 1-3 m^2 and 40.9% have gardens bigger than 9 m^2. One hundred and seventeen from 198 samples (59.1%) have gardens in the home and so they can compost a considerable part of household wastes. As a main part of sample (40.9%) have not garden in the home, municipality should provide technologies for composting which does not need to home garden and let the family to prepare the compost in enclosed containers inside the home to reduce the volume of household wastes.

Table 1 shows the relation of home garden area and waste production by each family in each collection. This data indicates that with exception of homes that have gardens bigger than 9 m^2, there is no remarkable difference in waste production between other homes. In other word, home garden has not any effect on household waste production. Furthermore, families are not usually compost the organic compostable wastes and nearly all household wastes are collecting by municipal workers.

Relation of home area and household waste production is shown in Table 2. There is no significant difference between five levels of home area with household waste production.

Family size: Family size is an important determinant of household waste production. Per capita waste production and total family waste production increased by increasing family size (Table 3). Other studies also proved this claim that family size has a direct relation with household waste production.

Day stay in home: The mean number of family members staying at home during the day in this study is 1.8 person. The number of family members which stay in home during the day may have a negative effect on household waste production, because they can compost at least a part of organic wastes, though this is highly dependent to education them how compost should be prepared. Another belief is that staying family members in home during the day may have a positive effect on household waste production and increases it.

Table 1: Mean household waste production base on home garden area (m^2)

Home garden area (m^2)	Mean waste production (kg day^{-1})
1-3	3.65
3.5-6	5.17
6.5-9	5.00
More than 9	1.00
Homes without garden	3.40
Total mean	4.39

Table 2: Mean household waste production base on home area (m^2)

Home area (m^2)	Mean waste production (kg day^{-1})
50-80	4.25
81-110	4.34
111-140	4.48
141-170	4.45
More than 170	4.70
Total mean	4.39

Table 3: Test of effect of family size on household waste production

Family size (Person)	Mean waste production (kg day^{-1})	Per capita waste production (kg day^{-1})
1-3	3.61^b	0.54^b
4-6	3.99^b	0.59^b
7-9	4.60^b	0.84^b
More than 9	6.31^a	1.92^a
Total mean	4.39	0.95

Means with different letters (s) are significantly different ($p<0.05$)

In this study however, because of lack of education for composting and lack of home garden in 40.9% of samples, it seems that staying people in home has increased household waste production. Table 4 presents data of household waste production in two groups: First group who stay at least one person in home during the day and the second group in which nobody stay in home during the same time. Statistical analysis showed that there is a significant difference in household waste production between these two groups; so, it seems that staying in home during some hours of the day would result in producing more household waste in this situation (Table 4).

Home tenure: At first in a sociologic point of view, it seems that home tenure should not affect household waste production. In this study, 79.3% of samples had private homes. χ^2 statistic ($\chi^2 = 67.95$) showed that there is a significant difference between two groups of home tenure. Daily household waste productions in private and rental homes are 4.41 and 4.30 kg, respectively. Furthermore, per capita household waste production in private and rental homes in each collecting is respectively 0.95 and 0.92 kg t-test showed that these two means are not significantly different. This finding shows that home tenure has not any effect on household waste production.

Household waste separation: Waste separation in the home is an important factor for facilitating waste recycling and composting as well as reducing collecting costs by municipality workers and separating in recycling and composting centers. Complete separation is also possible in home easily, while it is time and money consuming in these centers. Table 5 shows the separation of household wastes by families in Mashad. As shown in Table 5, more than 40% of sample society does not usually separate the wastes. Economic incentives as well as education about environmental benefits of waste separation by householders will result in active participation of people in separating wastes in the home. Paying money to householders for separated recyclable wastes such as plastic, glass and paper could increase the incentives of the householders by 50%. Also municipality can pay subsidy and discount to its services for families who participate in the waste separation program.

Table 4: Effect of staying in home during the day on household waste production

Group*	Frequency	%	Mean waste production (kg day^{-1})	Per capita waste production (kg day^{-1})
1	156	78.8	4.53	0.71
2	42	21.2	3.09	1.74
t statistic			3.38	-3.3
mean			4.39	0.95

*Group 1: at least one person stay in home during the day, group 2: Nobody stays in the home during the day, ** Significant ($p<0.01$)

Table 5: Evaluation of household behavior in Mashad to Separation of household wastes in the source place

Separation	Frequency	%
Yes	118	59.6
No	80	40.4
χ^2 statistic		7.29*

*Statistically significant ($p<0.01$)

Demand for collecting household wastes: In order to determine the demand of householders in Mashad for collecting household wastes, a linear regression model was applied. The fitted equation is as below:

$$D_{waste} = 2.85 - 0.38\,X_1 + 0.42\,X_2 - 0.003\,X_3 + 1.74 \times 10^{-6}\,X_4 + 1.15\,D_1 - 0.06\,D_2$$

The measures of X_1 to D_2 are , respectively 3.03,-1.62*, 3.55, -0.55, 1.16, 0.79, 02.56* and -0.14 (*indicates that the value of parameter is significant, $p< 0.01$, $R^2 = 0.21$, $R^{-2} = 0.16$ and $F = 4.79^*$).

Results of the equation show that 21% of variations in demand for collecting services are explained by three variables including number of family members who stay at home during the day, virtual variable of home type and family size. Although other variables are statistically non significant, but they may influence on demand for waste collecting services. As it is clear, the effect of X_1 (number of family members who stay at home during the day) on demand for waste collecting service is negative which is consistent with results of other reports (1, 4, 5, 6 and 8). Measures for home type shows that families who live in apartments have 1.15 units less demand for waste collecting services than families who live in other types of homes. In this study, it was determined that each family in apartments produces 3.45 kg day^{-1} household wastes, while other families produce 5 kg day^{-1} waste.

Variable X_4 (family income) is an approximate indicator of family consumption; so, it can be expected that has a positive effect on waste production and demand for its collecting services. In this study, although it was non significant, but it influenced positively the demand for waste collecting service. Home garden area (X_4) is another important factor on demand for waste collecting services. Home gardens make the composting possible inside the home and can reduce waste production and hence demand for household waste collecting services. In the present study, it had a positive (but statistically not significant) influence on demand for waste collecting services. This happens for two reasons. First, more than 40% of studied homes have not garden. Second, the area of many homes is too small to permit families composting organic wastes. Although variable D_2 is not statistically significant, but the measures show that

families which separated household wastes, produced less wastes, hence have fewer demand for waste collecting services.

The findings of the present study suggest that improving household waste management in Mashad requires further efforts by municipality, government and even environmental NGOs. Studies all over the world have proved that participation of private sectors and NGOs in solid waste management system will increase its efficiency (Kapepula *et al*., 2006; Rathi, 2006). Providing special kitchen containers by municipality to separate organic from non organic and solid versus wet household wastes will improve the household waste management efficiency (Kapepula *et al*., 2006). Discriminative pricing of collecting services by municipality or government also facilitates the separation of different parts of household wastes. Finally, education people directly by brochures, workshops or indirectly by advertisement in media such as newspapers, TV, radio or street billboards will help to aware the public about best household waste management practices. Preparing and distributing more brochures and posters about the solid waste recycling and performing meetings and lectures in schools and mosques (main places of gathering people for religious ceremonies) are suitable means to optimize solid waste management system.

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