



## Waste Separation at Household Level: Comparison and Contrast Among 40 Countries

### KEYWORDS

Waste Recycling Management, Households, Solid Waste, Sustainable practices

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**ABSTRACT** *This study is an outcome of a survey conducted on Fulbright fellows from 40 different countries, who were meeting at a Fulbright Seminar at Reno, Nevada State in the United States. The purpose of the research was to find out the current practices of managing household waste in different parts of the world in order to identify a possible sustainable solution to minimize dumping in landfills. In addition, the study allows us, to understand the systems (laws and regulations) related to recycling and hauling practices in order to create awareness and generate future research ideas. The methodology used is survey conducted on Fulbright fellows from 40 different countries. Short interaction with the respondents and unstructured interviews are the limitations of this study. The results of this paper are useful to gather research ideas on waste systems throughout the world. It will help to establish the relationship between different systems and its reasons. The paper can also help policy makers to incorporate the best practices and develop a sustainable model to manage waste.*

### INTRODUCTION

Travellers gain different waste management experiences when travelling around the world, particularly in situations when travellers are using apartments or bed and breakfast services. In these situations people face waste recycling problems every day. In some countries people can find one bin, in other countries two, three, four and more bins in households. The number of bins is only one problem in waste recycling in households. Of course, it is significant because a person must know which bin to use in which case. The second problem is more crucial, it is connected with the future of the recycled waste. There are various options: recycling the waste into different new materials; waste depositing in landfill (dumpsite); composting organic waste. The conducted research shows deep analysis of waste recycling in specific countries as case studies: the United Kingdom, Belgium, Korea, Japan, India, Latvia, Brazil, the European Union (EU) including 27 countries and others (Woodard et.al., 2004; Jacobsen et.al., 2013; Seunghae et.al., 2011; Matsumoto, 2011; Chakrabarti et.al., 2009; Cudecka-Purina et.al., 2012; The Gallup Organisation, 2011; Magram, 2011, Gutberlet, 2012). Analysis of waste separating for recycling in households is crucial, particularly at a global scale. The household is the first place for children to understand and learn consumption issues and the role of waste recycling in the community and in the world reference. On a global scale it is necessary to find ways to raise the number of households which are separating waste in the world, including regions which are just starting to think about waste management explain why. Several studies have been done about different factors that could make an impact on waste separation in households. A number of researches good use to frame and structure your writing has focused on monetary and tax policy issues (Fu 2010), legislation and normative rules (Magram, 2011) and others on impact of behaviour and education (Ittiravivongs, 2012, Gutberlet 2012; Godfrey et.al., 2013).

### LITERATURE REVIEW

Research in 27 European Countries (2011) shows attitudes of Europeans towards waste recycling in households. According this survey, 58% of respondents thought that their

household was not producing too much waste. 57% of respondents from Cyprus thought that they are producing too much waste, but 75% of respondents from Romania thought that they are producing too much waste. There is a high difference in opinions of generating waste between the EU member states. The average number of the EU member states demonstrates that 89% of respondents are separating at least some of their waste. In four countries (Luxemburg, Austria, Germany and Slovenia) only 3% of respondents mentioned that they are not separating waste for recycling or composting. Respondents from Bulgaria (42%) and Latvia (40%) demonstrate that they are not separating waste at households. (The Gallup Organisation, 2011) A Study from Thailand shows that only 20% of the annually generated waste is being recycled (Ittiravivongs, 2012).

The effort is to characterise the waste recycling policy in Latvia. A new National Waste Management Plan 2013-2020 has been elaborated and accepted by the Cabinet of Ministers in Latvia. The Waste Management Plan of Latvia is prepared by taking into consideration the main goals of the EU sustainable targets which are included in planning document "Europe 2020". The new plan of Latvia sets out that in the management of waste, stress on efficiency of waste management should be put to increase waste separating policy in households. Generally in Latvia there are public containers for plastic, paper and glass in different places which are accessible for society free of charge. The private sector deals mainly with waste management, including recycling in Latvia. There are a few cases when local municipalities are also collecting waste. The Waste Management Law of Latvia (2010) says that "An owner or a lessee within whose property municipal waste has been produced has a duty to ensure a place for a waste container and an access to the waste collection point for the vehicle of the waste manager who has entered into a contract with a local government regarding municipal waste management". Latvia is producing solid waste per year at the amount of 600 000 to 700 000 tons. Latvia is using the following tools for waste management policy: fee on waste management, tariff of waste disposal and tax of nature resources. Since 2010 Latvia has implemented the

best practices in state institutions in management of used paper, office equipment and batteries. The state institutions must hand in waste for recycling or put it in separate bins. The fee on waste management is calculated on the basis of the EU principle Pay-As-You-Throw. According to the statistical data of Latvia, one person per year is paying 0.7% of all household expenditures for waste management (Bureau of Central Statistics of Latvia, 2012). The goal of waste separation in Latvia is to provide available service of separated waste collection, including glass, paper, metal and plastic, for every person in each municipality before 1<sup>st</sup> January 2015.

#### WASTE COLLECTION MANAGEMENT & APPROACHES

Ways of collecting solid waste are different in different countries and inside countries, between local municipalities. This feature must be taken in account, comparing the research results with other researches which have been done in various countries or regions as particular case studies. The main types of solid waste for separate collection are identified by studying research cases of waste recycling and from the interview with a waste collection company in Latvia: plastic, paper, cardboard, glass, organic, garden waste, metal, textile, wood, rubber and leather, building materials, electronic waste (Tulukhonova et al., Halvorsen, 2012). Forms of the household waste separation are containers, public containers, eco bags, plastic bags, eco boxes, deposit system in markets/shops, eco grounds and eco points. The best known forms of waste separation in various countries are containers, public containers and plastic bags. Modes of collection of the household separate waste are door-to-door collection, drop-off grounds/containers, return for refund and return without refund. Halvorsen (2012) research of ten countries shows that collection of recycled materials mainly takes place through drop-off centres/containers.

Several previous researches have been done about institutional systems of waste management, including legislation, rules and financial issues. These two aspects legislation and financial mechanism are interactive and dependent on each other. Legislation is defining rules of waste collection and responsibilities of waste collection institution and household. The main approaches in organizing waste collection from households are private companies, municipalities, companies operated by municipalities or state operated companies.

#### METHODOLOGY

Survey of respondents from 40 countries, including Asia, Europe, Africa, North America, South America and Oceania is done using face to face interviews, personalised and e-mail questionnaire. Population are the other parameter for survey that includes profile of respondents, education, age, work in higher education or research, etc. Analysing and assessing results, restrictions of the research should be noted: one respondent from each country. It is especially important to consider these restrictions in the group of big countries, such as India, China, and USA.

#### DISCUSSION

With waste management emerging as one of the most critical issues modern society is facing today, studies from various European countries investigate the role of recycling to successfully manage the ever increasing magnitude of waste created by society (Waste Management, Productivity Commission Inquiry Report, 2006). The first step for the household recycling is waste segregation at source. In the absence of waste segregation practices, recycling has

remained to be an informal sector working on outdated technologies (Solid waste management: Challenges and prospect).

#### Waste separation at Household Level

There are many countries, like Poland, Belgium, Serbia, Bulgaria, Sri Lanka, Taiwan, Norway, the Philippines, Egypt and Latvia, that are using recycling bins at home. On the other side, some countries like Brazil, Russia, New Zealand, Indonesia and Argentina (La-Plata) have a 2-bin facility for dry and wet waste, whereas Moldova and Malaysia prefer 3 recycling bins for paper, plastic and glass. Some countries, like Portugal, the Czech Republic, Finland and Spain are using 4 or 5 bins at home for segregation of recycling waste for paper, plastic, metal, glass, compostable and e-waste (Table:1).

**Table 1: Recycling at Household Level**

Type of Bins	Country Name
<b>2 Bins:</b> Dry waste & Wet waste	Belgium, Serbia, Norway, Brazil, Argentina, Russia, New Zealand, Indonesia, Egypt
<b>3 Bins:</b> Paper, Plastic & Glass	The Philippines, Sri Lanka, Poland, Latvia, Moldova, Malaysia
<b>4 Bins:</b> Paper, Plastic, Glass & Organic	Bulgaria, Taiwan, Portugal, Spain
<b>5 Bins:</b> Paper, Plastic, Glass, Organic & E-waste	Finland
Source: Survey conducted by Authors	

Half of respondents from 20 countries are not separating waste at household level by using different bins for waste separation. They are using collection of mixed waste. It is because of lack of proper legislation, which culminates to attitude towards recycling and the costs associated with it.

#### Waste separation at Community Level

Recycling bins for paper, plastic, glass and waste at community level is one of the effective waste recycling practices which is being performed by Poland, Belgium, Serbia, Bulgaria, Taiwan, Greece, Norway, the Philippines, Latvia and New Zealand. Some countries like Brazil, Moldova, Portugal, the Czech Republic, Spain, France and Germany prefer 4 to 5 separate bins at community level that help to centralize waste at collection points and further transfer it to recovery station for recycling.

Countries like Tunisia, India, Ukraine, Kazakhstan, Cyprus, Argentina, Uganda, Nigeria, Ethiopia, Belarus, Togo, Pakistan and Turkmenistan are neither having any recycling bins at home nor at the community level (Table: 2).

**Table 2: Recycling at Community Level**

Bins at Community	
Yes	No
Brazil, Portugal, the Czech Republic, Taiwan, Latvia = <b>5 Bins</b>	Tunisia, India, Ukraine, Kazakhstan, Cyprus, Argentina, Uganda, Nigeria, Ethiopia, Belarus, Togo, Pakistan and Turkmenistan
Spain, Germany, Bulgaria = <b>4 Bins</b>	
Moldova, Poland, Belgium, Serbia, Greece, the Philippines, Latvia = <b>3 Bins</b>	
New Zealand = <b>2 Bins</b>	

Source: Survey conducted by Authors	
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**Policies and Penalty System**

There are negligible policies related to waste management in developing or developed countries, like Serbia, Sri Lanka, Egypt, Russia, Indonesia, Argentina, Moldova, Malaysia, Portugal and the Czech Republic; they do not have any waste management regulation policies.

Whereas some waste management practices, like environment protection act, are in force in Poland, New Zealand, Togo, Spain, Latvia and Finland. Apart from that, there is no penalty system if waste is not recycled in the following countries: Poland, Hungary, Belgium, Serbia, Bulgaria, Sri Lanka, Taiwan, the Philippines, Turkmenistan, Greece, Philippines, China, Latvia, Tunisia, Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Malaysia, Nigeria, Ethiopia, Belarus, Togo, France, Pakistan, Egypt and Indonesia. Only few European countries, like New Zealand, Spain, Finland, Germany and Norway have penalty systems of not recycling waste.

**Table 3: Policies and Penalty System**

Policies System		Penalty System	
Yes	No	Yes	No
Poland, New Zealand, Togo, Spain, Latvia, Hungary, Belgium, Bulgaria, Taiwan, Turkmenistan, Norway, the Philippines, China and Finland	Serbia, Sri Lanka, Egypt, Russia, Indonesia, Argentina, Moldova, Malaysia, Portugal and the Czech Republic	New Zealand, Spain, Finland, Germany and Norway	Poland, Hungary, Belgium, Serbia, Bulgaria, Sri Lanka, Taiwan, the Philippines, Turkmenistan, Greece, China, Latvia, Tunisia, Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Malaysia, Nigeria, Ethiopia, Belarus, Togo, France, Pakistan, Egypt and Indonesia
Source: Survey conducted by Authors			

**Collection and Transportation of waste**

After segregation of waste, collection and transportation is another issue in the following countries: Greece, Tunisia, Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Nigeria, Ethiopia, Belarus, Togo, Indonesia and Egypt, because there is a vendor problem to collect waste at home. Whereas in Poland, Belgium, Serbia, Bulgaria, Sri Lanka, Taiwan, Hungary, Turkmenistan, Norway, the Philippines, China, Latvia, India, New Zealand, Malaysia, Spain, France, Finland, Germany and Pakistan there are many public or private vendors to collect waste at home.

Similarly in some countries, like Kazakhstan, Brazil, the Czech Republic, Malaysia, Ethiopia, Belarus, Togo, Spain, France, Finland, Germany, Indonesia, Egypt, Poland, Sri Lanka, Turkmenistan, Norway and China, there are mandatory contracts with municipalities on waste collection. It is proved by the author's survey that the municipality is the major collector of waste rather than public or private vendors. In case of Latvia municipalities are responsible of

elaborating local regulations of waste collection.

**Table 4: Collection and Transportation of waste**

Collection of waste by Vendor		Collection of waste by Municipality	
Yes	No	Yes	No
Poland, Belgium, Serbia, Bulgaria, Sri Lanka, Taiwan, Hungary, Turkmenistan, Norway, the Philippines, China, Latvia, India, New Zealand, Malaysia, Spain, France, Finland, Germany, Latvia and Pakistan	Greece, Tunisia, Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Nigeria, Ethiopia, Belarus, Togo, Indonesia and Egypt	Kazakhstan, Brazil, the Czech Republic, Malaysia, Ethiopia, Belarus, Togo, Spain, France, Finland, Germany, Indonesia, Egypt, Poland, Sri Lanka, Turkmenistan, Norway and China	Tunisia, Ukraine, India, Cyprus, Argentina, Russia, Portugal, New Zealand, Nigeria, Pakistan, Belgium, Serbia, Bulgaria, Hungary, Taiwan, Greece, the Philippines

Source: Survey conducted by Authors

Thirteen respondents have provided a reply on question about the fee for waste collection per year in the household. It is important to note that at the first moment respondents said they did not know how much they are paying, but later they started to think about it. We discovered that paying policy of waste collection is very different: in 2 cases there is free waste collection, in 3 cases the fee is included in property taxes and in 5 cases there is the fee to vary between 75 and 100 USD annually from household. Three respondents indicated that they do not know anything about the waste fee.

**Environmental benefits from recycling practices**

While considering the benefit of recycling almost all countries, like Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Nigeria, Ethiopia, Belarus, Togo, Spain, France, Germany, Indonesia, Egypt, Poland, Hungary, Serbia, Bulgaria, Sri Lanka, Turkmenistan, Taiwan, Greece, the Philippines and Latvia believe that recycling at household is not sufficient and haven't provided any benefit. But some countries, like Belgium, Norway, China, India, Malaysia, Finland and Pakistan are performing recycling practices and get benefit in terms of environment protection and reduce the amount of waste.

**Table 5: Environmental benefits from recycling practices**

Countries getting benefit from recycling	
Yes	No
Belgium, Norway, China, India, Malaysia, Finland and Pakistan	Ukraine, Kazakhstan, Brazil, Cyprus, Argentina, Moldova, Russia, Uganda, Portugal, the Czech Republic, Nigeria, Ethiopia, Belarus, Togo, Spain, France, Germany, Indonesia, Egypt, Poland, Hungary, Serbia, Bulgaria, Sri Lanka, Turkmenistan, Taiwan, Greece, the Philippines and Latvia
Source: Survey conducted by Authors	

**Percentage of segregated volume of waste**

Amount of waste is varied from country to country, depending on the consumption pattern or living standard of the particular country, for example, 10% of waste generated in Poland is paper, 25% is plastic, 15% is organic waste, 15% is glass and 35% is other mixed waste. Belgium estimates 15%, 20%, 30%, 5% and 30% in paper, plastic, organic, glass and other waste respectively. Similarly, Serbia

estimates 30%, 30%, 20%, 10% and 10% in all categorized waste. Bulgaria generates 15% paper, 25% plastic, 30% organic, 5% glass and 25% other mixed waste. Sri Lanka estimates 25% paper, 25% plastic, 20% organic waste, 10% glass and 10% other mixed waste. Turkmenistan estimates 5% paper, 20% plastic, 50% organic waste, 10% glass and 15% other mixed waste. Similarly Greece produces 30%, 30% and 15% paper, plastic and glass waste respectively. The Philippines estimate 35% paper, 35% plastic and 35% organic waste. Latvia estimates 15% paper, 25% plastic, 25% organic waste, 10% glass and 25% other mixed waste.

Tunisia estimates 80% organic waste, 10% plastic waste, of paper and 5% glass waste. Two countries India and Pakistan estimate almost same amount of household waste, that is 65% organic waste, 15% paper, 15% plastic and 5% glass. Similarly two countries Brazil and Cyprus estimate 40% organic waste, 30% paper, 20% plastic, 5% glass and 5% metal waste from households. Ukraine generates 65%, 20%, 10% and 5% organic waste, plastic, paper and glass respectively. La-Plata estimates 50% organic waste, 20% plastic waste, 20% paper and 10% metal waste. Russia estimates 15% organic waste, 50% plastic waste, 5% paper, 20% glass waste and 10% metal waste from households. Uganda produces 80% food waste, 10% plastic waste and 20% paper waste. Other countries, like New Zealand, Portugal, the Czech Republic and Malaysia estimate the average amount of 25-30% organic waste, 40-50% plastic waste, 15-20% paper waste, 10% glass waste and 5-10% metal waste. Belarus estimates 30%, 40%, 10% and 20% food, plastic, paper and glass waste respectively. Togo and Indonesia mostly generate 70% organic waste and 30% plastic waste. Spain estimates 15% organic waste, 20% plastic waste and 15% paper waste from households. Two countries, like France and Germany, estimate the same amount of waste from household that is 50% organic waste, 25% plastic waste and 25% paper waste. Egypt estimates 30% food waste, 20% plastic waste, 30% paper waste and 20% glass waste from households.

**Table 6: Percentage of segregated waste**

Country and City Name	Number of population*	Paper (%)	Plastic (%)	Food (%)	Glass (%)	Metal (%)
Argentina (La-Plata)	740369	20	20	50		10
Argentina (Puerto Msdrn)	73612					
Belarus (Minsk)	2002600	10	40	30	20	
Belgium (Liège)	195576	15	20	30	5	30
Brazil (Curitiba)	1764540	20	30	40	5	5
Bulgaria (Sofia)	1241396	15	25	30	5	25
China (Unemgi Xinjiang)	na					
Cyprus (Nicosia)	310355	20	30	40	5	5
Egypt (Cairo)	9120350	30	20	30	20	
Ethiopia (Hawassa)	165275					
Finland (Tampere)	217497					
France (Paris)	2234105	25	25	50		
Germany (Morth)	na	25	25	50		
Greece (Athens)	3089698	30	30	0	15	0
Hungary (Budapest)	1741041					

India (Noida)	642381	15	15	65	5	
Indonesia (Papua)	2833381		30	70		
Kazakhstan (Aktobe)	371546					
Latvia (Sigulda)	11 368	15	25	25	10	25
Malaysia (Kualalampur)	1627172	20	40	30	5	5
Moldova (Chisindu)	671800					
New Zealand (Auckland)	1397300	10	50	20	10	10
Nigeria (Zaria)	408198					
Norway (Bergen)	260392					
Pakistan (Islamabad)	1151868	15	15	65	5	
Poland (Bialystok)	294399	10	25	15	15	35
Portugal (Evora)	56596	15	50	30	5	
Russia (Moscow)	11503501	5	50	15	20	10
Serbia (Novi sad)	250439	30	30	20	10	10
Spain (Coruna)	246056	15	20	15		
Sri Lanka, (Colombo)	752993	25	25	20	10	10
Taiwan (Tainan)	1876312					
The Czech Republic (Prague)	1262106	20	20	30	20	10
The Philippines (Maqalang)	103597	35	35	35		
Togo (Lome)	695100		30	70		
Tunisia (Gabes)	116323	5	10	80	5	
Turkmenistan (Ashgabat)	1031992	5	20	50	10	15
Uganda (Kampala)	1208544	20	10	80		
Ukraine (Donetsk)	975959	10	20	65	5	

Source: Survey conducted by Authors; \* Data of population is collected from Wikipedia The Free Encyclopaedia

**Training and awareness program for recycling**

For the success of recycling programs in households most of the countries, like Hungary, Bulgaria, Greece, Norway, the Philippines, China, Latvia, Brazil, Cyprus, Moldova, Russia, Uganda, Portugal, the Czech Republic, New Zealand, Malaysia, Nigeria, Spain, France, Finland and Germany provide training and education on environment at school/college level to promote recycling practices at households. While on the other side, some of the countries, like Tunisia, India, Ukraine, Kazakhstan, Argentina, Ethiopia, Belarus, Togo, Indonesia, Egypt and Pakistan Belgium, Serbia, Sri Lanka and Turkmenistan are not focusing on training and awareness programs that lead to low or negligible benefit of recycling.

**Table 7: Training and awareness program for recycling**

Yes	No
Hungary, Bulgaria, Greece, Norway, the Philippines, China, Latvia, Brazil, Cyprus, Moldova, Russia, Uganda, Portugal, the Czech Republic, New Zealand, Malaysia, Nigeria, Spain, France, Finland and Germany	Tunisia, India, Ukraine, Kazakhstan, Argentina, Ethiopia, Belarus, Togo, Indonesia, Egypt, Pakistan, Belgium, Serbia, Sri Lanka and Turkmenistan
Source: Survey conducted by Authors	

## CONCLUSION

The process of waste segregation and collection differs from country to country. Door to door collection of the waste is most common method. The survey highlights this complex issue of recycling household waste. To get the actual status of household waste recycling, authors framed specific questions on policies and regulations, collection and transportation of waste, recycling at community level. Few questions are on level of segregation, environmental benefit from recycling and training and awareness programs. Recycling of waste depends on the percentage of waste material segregated, for example, waste is segregated into 5-bin categorization as paper, plastic, food, glass and metal. The percentage of segregated waste material differs from others, like Gabes in Tunisia having population around 116323 that segregate 5% of paper, 10% of plastic, 80% of food and 5% of glass. Similarly, Moscow in Russia having population around 11503501 segregate 5% of paper, 50% of plastic, 15% of food, 20% of glass and 10% of metal. Segregation of paper at Magalang in Philippines shows the highest percentage i.e. 35%. Plastic waste segregation at New Zealand (Auckland) and Portugal (Evora) achieved the highest score of 50%. Tunisia (Gabes) and Uganda (Kampala) achieved 80% in food waste segregation and use it for composting. Russia (Moscow), the Czech Republic (Prague), Belarus (Minsk) and Egypt (Cairo) segregate almost 20% of glass for recycling; lastly, in metal waste segregation Poland (Bialystok) is the only one nation that achieved 35%.

As the data revealed, 4-bin and 5-bin categorization of waste is more successful because of recycling purposes done by Bulgaria, Taiwan, Portugal, Spain and Finland. At a large scale, centralized waste recycling units at community level get more benefit. Countries like Brazil, Portugal, the Czech Republic, Taiwan, Latvia, Spain, Germany, Bulgaria, Moldova, Poland, Belgium, Serbia, Greece, the Philippines, Latvia and New Zealand are doing the same. As we know, waste has both reversible as well as irreversible impact on human health and environment. It is necessary for all developing and developed countries to monitor their policies and regulations on waste handling to reduce waste and to promote recycling. Other alternatives for the same are to implement a penalty system as New Zealand, Spain, Finland, Germany and Norway does. Thus, it can be concluded that segregation of waste is more important than putting number of bins at different places. As from discussions with members of different countries it seems that recycling of waste is only possible if waste is segregated at source either at community level or household level.

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