

## APPLYING BORDA COUNT METHOD FOR DETERMINING THE BEST WEEE MANAGEMENT IN EUROPE

*Maria-Loredana POPESCU<sup>1</sup>*

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### ABSTRACT

*This article presents the Borda Count method and its application for ranking the European countries regarding the WEEE\* management. The objective of the paper is to determine the best WEEE management system in Europe. The contribution of the research consists in presenting the hierarchy on the WEEE management according to three indicators of efficiency: WEEE collection efficiency related to the amount of equipment put on the market, the efficiency of reuse and recycling of WEEE related to the amount of equipment put on the market and the efficiency of reuse and recycling of WEEE related to the amount of collected WEEE.*

**KEYWORDS:** *Borda Count method, collecting, recycling, WEEE management efficiency.*

**JEL CLASSIFICATION:** *C19, Q53, Q56, Q59.*

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### 1. INTRODUCTION

Borda count method involves a voting system of candidates, alternatives in order of preference, giving points for each candidate or alternative. The original Borda vote-counting scheme was introduced in 1770 by Jean Charles de Borda and adopted by the French Academy of Sciences with the purpose of selecting its members (Davide Buscaldi and Paolo Rosso, 2007).

In a Borda count, the last preference cast should receive 1 point, the voter's penultimate ranking should get 2 points, and so on (Peter Emerson, 2013). Regarding assigning point, depends how much alternatives we have, for example, if we have 3 alternatives, we assign 3 points for 1<sup>st</sup> place, 2 points for 2<sup>nd</sup> place and 1 point for 3<sup>rd</sup> place, in order of preference of course. The final score for each candidate is calculated as the sum of the products of the points allocated to each place and the number of assigned votes.

In this paper, I took into account 28 European countries where I considered important three criteria for effective management of electrical and electronic equipment. I assigned points to each criterion according to the place of each country as follows: the country on the first place gets 28 points, the country on the second place is voted with 27 points and so on until the country on the last place (28<sup>th</sup> country/country ranked 28) which is assigned with one point. So I proceeded to each criterion in part and in the end I passed the results in a table calculating for each country the total number of points meeting those three criteria. For example, if a country has for the first criterion the 3<sup>rd</sup> place, for the second criterion the 6<sup>th</sup> place and for the third criterion the 9<sup>th</sup> place, the final result will be:  $1 \times 26 + 1 \times 23 + 1 \times 20 = 69$  points. If another country is out of 3 times the 5<sup>th</sup> (at each of the three criteria it was ranked the 5<sup>th</sup> place), taking into account that the 5<sup>th</sup> place is ranked with 24 points, the total number of points will be  $3 \times 24 = 72$  points. The country with the highest total score is the winner. In the next parts of the paper, Borda count method is applied on WEEE quantities, being presented the final results and discussions.

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<sup>1</sup> The Bucharest University of Economic Studies, Bucharest, Romania, e-mail: maria.loredana\_popescu@yahoo.com

\* Abbreviation for Waste Electrical and Electronic Equipment

## 2. APPLYING BORDA COUNT METHOD

I analysed the quantities of electrical and electronic equipments put on the market and then the amount of waste electrical and electronic equipments collected, recycled and reused in 2010. I took the existing data on the Eurostat statistics for 28 European countries and I realized a classification according to the mentioned amounts, taken into account the sorting criteria, using the Borda Count. In table 1, there are presented the quantities of WEEE expressed in kg/capita/year in 2010:

**Table 1: Status of WEEE in EU (kg / capita / year) in 2010**

<i>Current issue</i>	<i>European countries</i>	<i>EEE** put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>
1	Belgium	26.97	9.67	7.75
2	Bulgaria	6.92	6.09	4.77
3	Czech Republic	15.85	5.06	4.39
4	Denmark	26.6	14.95	12.49
5	Germany	21.16	9.5	7.86
6	Estonia	9.87	4.21	3.48
7	Ireland	21.13	9.74	7.83
8	Greece	15.98	4.17	4.09
9	Spain	16.03	3.39	2.29
10	France	25.23	6.69	5.18
11	Italy	18.47	9.63	8.3
12	Cyprus	23.12	3.15	2.25
13	Latvia	7.29	2.04	1.73
14	Lithuania	7.75	2.88	2.09
15	Luxembourg	33.57	9.51	8.15
16	Hungary	12.42	4.05	3.34
17	Netherlands	3.71	7.71	6.16
18	Austria	19.76	8.85	7.07
19	Poland	12.76	2.94	2.31
20	Portugal	14.86	4.41	3.75
21	Romania	7.47	1.3	1.1
22	Slovenia	13.88	4.23	3.32
23	Slovakia	9.14	4.07	3.54
24	Finland	27.62	9.48	8.39
25	Sweden	24.78	17.21	14.45
26	United Kingdom	24.45	7.64	-***
27	Iceland	22.25	5	3.33
28	Malta	34.48	3.7	2.09

Source: adapted from Eurostat ([epp.eurostat.ec.europa.eu](http://epp.eurostat.ec.europa.eu)), accessed on 12.05.2014

\*\* Electrical and Electronic Equipment  
\*\*\* not available on Eurostat statistics

In table 2 appears the hierarchy on the management of WEEE according to the indicator efficiency of collection of WEEE related to the amount of equipment put on the market.

**Table 2: Ordering by the criterion of efficiency of collection of WEEE related to the amount of equipment put on the market (kg/capita/year) in 2010**

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>WEEE collection efficiency related to the amount of equipment put on the market</i>	<i>Place</i>
28	Netherlands	3.71	7.71	6.16	2.0781	1
27	Bulgaria	6.92	6.09	4.77	0.88	2
26	Sweden	24.78	17.21	14.45	0.6945	3
25	Denmark	26.6	14.95	12.49	0.562	4
24	Italy	18.47	9.63	8.3	0.5213	5
23	Ireland	21.13	9.74	7.83	0.4609	6
22	Germany	21.16	9.5	7.86	0.4489	7
21	Austria	19.76	8.85	7.07	0.4478	8
20	Slovakia	9.14	4.07	3.54	0.4452	9
19	Estonia	9.87	4.21	3.48	0.4265	10
18	Lithuania	7.75	2.88	2.09	0.3716	11
17	Belgium	26.97	9.67	7.75	0.3585	12
16	Finland	27.62	9.48	8.39	0.3432	13
15	Hungary	12.42	4.05	3.34	0.326	14
14	Czech Republic	15.85	5.06	4.39	0.3192	15
13	United Kingdom	24.45	7.64	-	0.3124	16
12	Slovenia	13.88	4.23	3.32	0.3047	17
11	Portugal	14.86	4.41	3.75	0.2967	18
10	Luxembourg	33.57	9.51	8.15	0.2832	19
9	Latvia	7.29	2.04	1.73	0.2798	20
8	France	25.23	6.69	5.18	0.2651	21
7	Greece	15.98	4.17	4.09	0.2609	22
6	Poland	12.76	2.94	2.31	0.2304	23

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>WEEE collection efficiency related to the amount of equipment put on the market</i>	<i>Place</i>
5	Iceland	22.25	5	3.33	0.2247	24
4	Spain	16.03	3.39	2.29	0.2114	25
3	Romania	7.47	1.3	1.1	0.174	26
2	Cyprus	23.12	3.15	2.25	0.1362	27
1	Malta	34.48	3.7	2.09	0.1073	28

Source: data processing, adapted from Eurostat (epp.eurostat.ec.europa.eu), accessed on 12.05.2014

On this criterion, as shown in table 2, the first place is occupied by Netherlands with 28 points, the second place is for Bulgaria with 27 points, the third place is for Sweden with 26 points and the last place is for Malta with 1 point.

In table 3 appears the hierarchy on the management of WEEE according to the indicator efficiency of reuse and recycling of WEEE related to the amount of equipment put on the market.

**Table 3: Ordering by the criterion of efficiency of reuse and recycling of WEEE related to the amount of equipment put on the market (kg/capita/year) in 2010**

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>Efficiency of reuse and recycling of WEEE related to the amount of equipment put on the market</i>	<i>Place</i>
28	Netherlands	3.71	7.71	6.16	1.6603	1
27	Bulgaria	6.92	6.09	4.77	0.6893	2
26	Sweden	24.78	17.21	14.45	0.5831	3
25	Denmark	26.6	14.95	12.49	0.4695	4
24	Italy	18.47	9.63	8.3	0.4493	5
23	Slovakia	9.14	4.07	3.54	0.3873	6
22	Germany	21.16	9.5	7.86	0.3714	7
21	Ireland	21.13	9.74	7.83	0.3705	8
20	Austria	19.76	8.85	7.07	0.3577	9
19	Estonia	9.87	4.21	3.48	0.3525	10
18	Finland	27.62	9.48	8.39	0.3037	11
17	Belgium	26.97	9.67	7.75	0.2873	12
16	Czech Republic	15.85	5.06	4.39	0.2769	13
15	Lithuania	7.75	2.88	2.09	0.2696	14

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>Efficiency of reuse and recycling of WEEE related to the amount of equipment put on the market</i>	<i>Place</i>
14	Hungary	12.42	4.05	3.34	0.2689	15
13	Greece	15.98	4.17	4.09	0.2559	16
12	Portugal	14.86	4.41	3.75	0.2523	17
11	Luxembourg	33.57	9.51	8.15	0.2427	18
10	Slovenia	13.88	4.23	3.32	0.2391	19
9	Latvia	7.29	2.04	1.73	0.2373	20
8	France	25.23	6.69	5.18	0.2053	21
7	Poland	12.76	2.94	2.31	0.181	22
6	Iceland	22.25	5	3.33	0.1496	23
5	Romania	7.47	1.3	1.1	0.1472	24
4	Spain	16.03	3.39	2.29	0.1428	25
3	Cyprus	23.12	3.15	2.25	0.0973	26
2	Malta	34.48	3.7	2.09	0.0606	27
1	United Kingdom	24.45	7.64	-	-	28

Source: data processing, adapted from Eurostat (ep.eurostat.ec.europa.eu), accessed on 12.05.2014

According to table 3, the first place goes to Netherlands with 28 points, second place to Bulgaria with 27 points, third place to Sweden with 26 points and last place is occupied by the UK with 1 point.

In table 4 appears the hierarchy on the management of WEEE according to the indicator efficiency of reuse and recycling of WEEE related to the amount of collected WEEE.

**Table 4: Ordering by the criterion of efficiency of reuse and recycling of WEEE related to the amount of WEEE collected (kg/capita/year) in 2010**

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>Efficiency of reuse and recycling of WEEE related to the amount of collected WEEE</i>	<i>Place</i>
28	Greece	15.98	4.17	4.09	0.9808	1
27	Finland	27.62	9.48	8.39	0.885	2
26	Slovakia	9.14	4.07	3.54	0.8697	3
25	Czech Republic	15.85	5.06	4.39	0.8675	4
24	Italy	18.47	9.63	8.3	0.8618	5
23	Luxembourg	33.57	9.51	8.15	0.8569	6
22	Portugal	14.86	4.41	3.75	0.8503	7
21	Latvia	7.29	2.04	1.73	0.848	8

<i>Rating assigned by country (points)</i>	<i>European countries</i>	<i>EEE put on the market</i>	<i>Collected WEEE</i>	<i>Recycled and reused WEEE</i>	<i>Efficiency of reuse and recycling of WEEE related to the amount of collected WEEE</i>	<i>Place</i>
20	Romania	7.47	1.3	1.1	0.8461	9
19	Sweden	24.78	17.21	14.45	0.8396	10
18	Denmark	26.6	14.95	12.49	0.8354	11
17	Germany	21.16	9.5	7.86	0.8273	12
16	Estonia	9.87	4.21	3.48	0.8266	13
15	Hungary	12.42	4.05	3.34	0.8246	14
14	Ireland	21.13	9.74	7.83	0.8039	15
13	Belgium	26.97	9.67	7.75	0.8014	16
12	Netherlands	3.71	7.71	6.16	0.7989	17
11	Austria	19.76	8.85	7.07	0.7988	18
10	Poland	12.76	2.94	2.31	0.7857	19
9	Slovenia	13.88	4.23	3.32	0.7848	20
8	Bulgaria	6.92	6.09	4.77	0.7832	21
7	France	25.23	6.69	5.18	0.7742	22
6	Lithuania	7.75	2.88	2.09	0.7256	23
5	Cyprus	23.12	3.15	2.25	0.7142	24
4	Spain	16.03	3.39	2.29	0.6755	25
3	Iceland	22.25	5	3.33	0.666	26
2	Malta	34.48	3.7	2.09	0.5648	27
1	United Kingdom	24.45	7.64	-	-	28

Source: data processing, adapted from Eurostat (epp.eurostat.ec.europa.eu), accessed on 12.05.2014

The third criterion presented in table 4 designates Greece on the first place with 28 points, Finland on second place with 27 points, Slovakia on third place with 26 points and UK on the last place with 1 point.

### 3. RESULTS AND DISCUSSION

Given the three criteria mentioned above, after applying the Borda Count method, Italy is the 'winner' country with 72 points in terms of achieving efficiency in the management of waste electrical and electronic equipment. Netherlands appears 2 times on 1<sup>st</sup> place, but 17<sup>th</sup> place at the criterion of recycling related to collection determine to win 4<sup>th</sup> place, being followed by Denmark and Bulgaria (68 and 62 points). The 2<sup>nd</sup> and 3<sup>rd</sup> places belong to Sweden and Slovakia. Among the last places appears Romania on the 21<sup>st</sup> with 28 points in the ranking of the 28 European states, followed by France, Poland, United Kingdom, Iceland, Spain, Cyprus and Malta as shown in table 5.

**Table 5: Final results after applying Borda Count method**

European countries	1 - 28 pts	2 - 27 pts	3 - 26 pts	4 - 25 pts	5 - 24 pts	6 - 23 pts	7 - 22 pts	8 - 21 pts	9 - 20 pts	10 - 19 pts	11 - 18 pts	12 - 17 pts	13 - 16 pts	14 - 15 pts	15 - 14 pts
Italy	0	0	0	0	72	0	0	0	0	0	0	0	0	0	0
Sweden	0	0	52	0	0	0	0	0	0	19	0	0	0	0	0
Slovakia	0	0	26	0	0	23	0	0	20	0	0	0	0	0	0
Netherlands	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Denmark	0	0	0	50	0	0	0	0	0	0	18	0	0	0	0
Bulgaria	0	54	0	0	0	0	0	0	0	0	0	0	0	0	0
Germany	0	0	0	0	0	0	44	0	0	0	0	17	0	0	0
Finland	0	27	0	0	0	0	0	0	0	0	18	0	16	0	0
Ireland	0	0	0	0	0	23	0	21	0	0	0	0	0	0	14
Czech Republic	0	0	0	25	0	0	0	0	0	0	0	0	16	0	14
Estonia	0	0	0	0	0	0	0	0	0	38	0	0	16	0	0
Austria	0	0	0	0	0	0	0	21	20	0	0	0	0	0	0
Greece	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belgium	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0
Portugal	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	30	14
Luxembourg	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0
Lithuania	0	0	0	0	0	0	0	0	0	0	18	0	0	15	0
Latvia	0	0	0	0	0	0	0	21	0	0	0	0	0	0	0
Slovenia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romania	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
United Kingdom	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iceland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyprus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: data processing using Eurostat statistics ([epp.eurostat.ec.europa.eu](http://epp.eurostat.ec.europa.eu)) accessed on 12.05.2014

**Continuation of table 5: Final results after applying Borda Count method**

European countries	16 - 13 pts	17- 12 pts	18- 11 pts	19- 10 pts	20- 9 pts	21- 8 pts	22- 7 pts	23- 6 pts	24- 5 pts	25- 4 pts	24- 3 pts	27- 2 pts	28- 1 pts	Total points
Italy	0	0	0	0	0	0	0	0	0	0	0	0	0	72
Sweden	0	0	0	0	0	0	0	0	0	0	0	0	0	71
Slovakia	0	0	0	0	0	0	0	0	0	0	0	0	0	69
Netherlands	0	12	0	0	0	0	0	0	0	0	0	0	0	68
Denmark	0	0	0	0	0	0	0	0	0	0	0	0	0	68
Bulgaria	0	0	0	0	0	8	0	0	0	0	0	0	0	62
Germany	0	0	0	0	0	0	0	0	0	0	0	0	0	61
Finland	0	0	0	0	0	0	0	0	0	0	0	0	0	61
Ireland	0	0	0	0	0	0	0	0	0	0	0	0	0	58
Czech Republic	0	0	0	0	0	0	0	0	0	0	0	0	0	55
Estonia	0	0	0	0	0	0	0	0	0	0	0	0	0	54
Austria	0	0	11	0	0	0	0	0	0	0	0	0	0	52
Greece	13	0	0	0	0	0	7	0	0	0	0	0	0	48
Belgium	13	0	0	0	0	0	0	0	0	0	0	0	0	47
Portugal	0	12	11	0	0	0	0	0	0	0	0	0	0	45
Hungary	0	0	0	0	0	0	0	0	0	0	0	0	0	44
Luxembourg	0	0	11	10	0	0	0	0	0	0	0	0	0	44
Lithuania	0	0	0	0	0	0	0	6	0	0	0	0	0	39
Latvia	0	0	0	0	18	0	0	0	0	0	0	0	0	39
Slovenia	0	12	0	10	9	0	0	0	0	0	0	0	0	31
Romania	0	0	0	0	0	0	0	0	5	0	3	0	0	28
France	0	0	0	0	0	16	7	0	0	0	0	0	0	23
Poland	0	0	0	10	0	0	7	6	0	0	0	0	0	23
United Kingdom	13	0	0	0	0	0	0	0	0	0	0	0	2	15
Iceland	0	0	0	0	0	0	0	6	5	0	3	0	0	14
Spain	0	0	0	0	0	0	0	0	0	12	0	0	0	12
Cyprus	0	0	0	0	0	0	0	0	5	0	3	2	0	10

Source: data processing using Eurostat statistics ([epp.eurostat.ec.europa.eu](http://epp.eurostat.ec.europa.eu)) accessed on 12.05.2014



The Directive 2002/96/EC on waste electrical and electronic equipment came into force on 13<sup>th</sup> of February 2003, being then replaced by Directive 2012/19/EU of 4<sup>th</sup> July 2012. For example, considering the gross domestic product (GDP) and the amount of WEEE generated in Italy and Romania, the amount of waste that have to be managed is directly proportional with the economic development of a country: in Italy, in 2006, the GDP was 31.3 USD/capita 17.6 kg/capita WEEE, while in Romania, the GDP in 2007 was 7.9 USD/capita with 5.5 kg/capita (Vincenzo Torretta, Marco Ragazzi, Irina Aura Istrate, Elena Cristina Rada, 2013).

Before 2008, Italy had many difficulties with alignment to the European Union regulations regarding the separate collection of WEEE. These difficulties were caused by several factors such as lack of clear regulations, lack of funds to cover the organization of collection centers and not complying regulations. After a first phase of implementing the new standards in the management of electronic waste, separate collection was possible in Italy, being made a great effort to organize the separate collection and treatment of WEEE with strong cooperation and involvement of citizens with initiatives in schools to arrange a specific delivery point for WEEE collection in all areas, for example ecopoints, ecological islands. The goal of educational activities was to identify possible actions that could help people to reduce waste through a coordinated activity. So the separate collection of WEEE began in Italy in 2008, and since 2009 the situation has improved remarkably.

The existence of an international treatment factory and the emergence of other private initiatives is a prerequisite for an increase in the WEEE recovery (Ciocoiu et al., 2010).

To ensure proper treatment of WEEE in order to protect human health and the environment, Sweden has implemented the WEEE management legislation on 9<sup>th</sup> of July 2001. The main parties involved in the management of WEEE in accordance with Swedish law are consumers, municipalities and producers. Consumers can return their old products to retailers when they buy new products. They can leave WEEE to municipal collection points and the business customers are responsible to cover expenses for WEEE treating, except those where it is applied the rule old for new. Local authorities deal with the management of collection points for household consumers. Manufacturers are required to cover the cost of collection and treatment of WEEE and they must handle properly the collected WEEE from the point of view of health and the environment and to provide information for household about the collection system. Retailers must accept WEEE from consumers using the rule old for new.

Netherlands, France, Germany, Belgium and the UK began the collection of WEEE earlier than Italy and Romania and now have a better collection per capita (Huisman, 2010).

In Netherlands, the waste management system was launched in January 1999, being the first comprehensive world system of consumer goods. Dutch law allows the use of visible environmental taxes, which was launched in January 1999 too as a financing instrument ([www.minind.ro](http://www.minind.ro)).

#### **4. CONCLUSIONS**

The collection of WEEE from households to specially designated points is a major problem in developing countries. In many European countries, this type of waste can be brought to collection points free of charge, but the mentality and education of the population has an essential role in the system of collection of WEEE. Public information campaigns regarding separate collection of WEEE contribute to improve management of WEEE.

For the WEEE management, besides involving producers, it is required a greater involvement of local authorities and citizens. Developing countries may take as a model the waste management system from developed countries, even if the implementation takes time. A system that has proven to be effective is found in Sweden, this is the country where the wastes which are not recycled, are transformed into energy (<http://www.ecologic.rec.ro/articol/read/actualitate/8777>).

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